

3.1.5 Groundwater Data Interpretation and Evaluation

This section provides a summary of groundwater monitoring performed in 2007, separated into RFLMA-required and non-RFLMA-required. A discussion of groundwater conditions during 2007, focusing on areas of interest (i.e., major plumes), is then presented.

3.1.5.1 RFLMA Groundwater Monitoring Activities of 2007

Groundwater was monitored in accordance with RFLMA beginning in March 2007, when that agreement was signed. Several samples were also collected from the OU 1 Plume wells in accordance with the 2006 IMP (DOE 2006c, 2006d), before RFLMA was signed (Figure 3-202). Routine activities of the groundwater monitoring program in 2007 included sample collection, water level measurement, and well maintenance. Note that this “groundwater” monitoring also includes monitoring activities at several surface-water locations, as well as at some locations that may not clearly belong to either category. Examples of the former include performance monitoring locations within streams and ponds; examples of the latter include locations monitoring effluent from a treatment system. However, because all of these locations support groundwater monitoring objectives, the data collected from them in support of these objectives are included as part of the groundwater discussion.

The groundwater monitoring program also performed special, non-RFLMA monitoring to support various objectives. This is discussed in Section 3.1.5.2. Analytical data and other information generated via RFLMA (a.k.a. routine) and non-RFLMA (a.k.a. nonroutine) sampling have been reported in the corresponding quarterly reports (DOE 2007g, 2007h, and 2008a) and are included in Appendix B.

The network of groundwater monitoring locations changed during 2007 with the implementation of RFLMA. Changes largely represented requests and comments from the IMP/Water Working Group made during development of the 2005 IMP (K-H 2005d, 2005e), as reported in the 2005 and 2006 Annual Reports (DOE 2006e, 2007e). A summary of these changes, as implemented via RFLMA, is presented in Table 3-80. In addition to these changes, Sentinel well 45605, which was installed within the slump block south of former B991, was abandoned in late 2007 to make way for regrading activities on that hillside. A replacement well will be installed in 2008. The schedule by which this well was abandoned and will be replaced is planned such that no required samples will be missed from this location. (See Section 3.1.5.4 for additional discussion on this topic.)

Table 3-80. Changes to the Groundwater Monitoring Network in 2007

Location	General Area	Nature of Change	Reason for Change
15199	MSPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group
15299	MSPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group
15399	MSPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group
15499	MSPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group

Table 3–80 (continued). Changes to the Groundwater Monitoring Network in 2007

Location	General Area	Nature of Change	Reason for Change
15599	MSPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group
15799	MSPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group
16199	MSPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group
16299	MSPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group
16399	MSPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group
16499	MSPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group
16599	MSPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group
3586	MSPTS	Required by IMP, not required by RFLMA	Unnecessary; per IMP group
70799	SPPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group
70899	SPPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group
70999	SPPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group
71099	SPPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group
70299	SPPTS	Required by IMP, not required by RFLMA	Unnecessary; per IMP group, selected 70099 for retention rather than 70299 due to quicker response time by the former well
1786	SPPTS	Required by IMP, not required by RFLMA	Unnecessary; per IMP group
SPP Discharge Gallery	SPPTS	Required by IMP, not required by RFLMA	Unnecessary per RFLMA; however, retained in operational monitoring per the RFSOG
95699	ETPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group
95799	ETPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group
95899	ETPTS	Required by IMP, not required by RFLMA	Unnecessary, water level only; per IMP group
0487	OU1	Required by IMP, not required by RFLMA	Unnecessary; per IMP group
4787	OU1	Required by IMP, not required by RFLMA	Unnecessary; per IMP group
4887	OU1	Required by IMP, not required by RFLMA	Unnecessary; per IMP group
10992	OU1	Required by IMP, not required by RFLMA	Unnecessary; per IMP group
11092	OU1	Required by IMP, not required by RFLMA	Unnecessary; per IMP group
P114389	FC-1	Required by IMP, not required by RFLMA	Water level only, not part of the remedy
37105	B371	Required by IMP, not required by RFLMA	Water level only, not part of the remedy
21605	North IA	Required by IMP, not required by RFLMA	Water level only, not part of the remedy
21305	North IA	Required by IMP, not required by RFLMA	Water level only, not part of the remedy
21002	North IA	Required by IMP, not required by RFLMA	Water level only, not part of the remedy

Table 3–80 (continued). Changes to the Groundwater Monitoring Network in 2007

Location	General Area	Nature of Change	Reason for Change
39605	B881	Required by IMP, not required by RFLMA	Water level only, not part of the remedy
37591	B891	Required by IMP, not required by RFLMA	Water level only, not part of the remedy
37691	904 Pad	Required by IMP, not required by RFLMA	Water level only, not part of the remedy
POM3	ETPTS	Required by IMP, not required by RFLMA	Was to be sampled in coordination with CDPHE at CDPHE's request, but no requests were made, location was never sampled
891WEL	881 Hillside	From quarterly Decision Document well to biennial Evaluation well	"Decision Document" classification eliminated, well is consistent with Evaluation well characteristics (in source area)
51605	North Walnut Creek	From semiannual Sentinel well to biennial Evaluation well	Per IMP group; more frequent data not needed
70099	SPPTS	From semiannual Decision Document well to semiannual Sentinel well	"Decision Document" classification eliminated, well is consistent with Sentinel well characteristics (in drainage, near edge of plume)
B206989	No Name Gulch	From semiannual Sentinel well to semiannual AOC well	CDPHE request; no AOC well exists downgradient of this well
4087	No Name Gulch	From semiannual Sentinel well to semiannual AOC well	CDPHE request; no AOC well exists downgradient of this well
SPPTS influent location	SPPTS	From SPPMM02 (a.k.a. piezometer 71099) to SPIN (the collection well)	SPPMM02 was defined as influent monitoring location before SPIN was installed; SPIN accurately represents influent, while SPPMM02 only approximates it
Site-wide	--	Groundwater samples for analysis of Pu and/or Am will be field-filtered using 0.45 um in-line filter	Pu and Am adhere to particulates, which do not represent a significant contaminant transport mechanism in Site groundwater
MOUND R1-0, MOUND R2-E	MSPTS	Eliminate gross alpha, gross beta, Pu, Am, and U from analytical suite	Historic data justify deletion of these constituents from the suite

Notes: OU 1 = former Operable Unit 1, a.k.a. the 881 Hillside. IMP group comprised of representatives of DOE, CDPHE, EPA, and area municipalities (who are also commonly referred to as stakeholders). MOUND R1-0 = influent MSPTS sampling location; MOUND R2-E = effluent MSPTS sampling location.

The groundwater monitoring network set forth in RFLMA is subdivided and categorized as shown in Table 3-81.

Table 3-81. RFLMA Monitoring Classifications for the 2007 Groundwater Monitoring Network

Well Classification	General Objective	Number of Wells	Monitoring Frequency
AOC	Monitor groundwater quality and water levels in a drainage downgradient of a contaminant plume or group of plumes	9	Semiannual (2x/year)
Boundary	Monitor groundwater quality and water levels in Woman Creek and Walnut Creek drainages at eastern (downgradient) Site boundary	2	Annual (1x/year)
Sentinel	Monitor groundwater quality and water levels near contaminant plume edges and in drainages	29	Semiannual (2x/year)
Evaluation	Monitor groundwater quality and water levels in or near contaminant source areas and in the former IA	42	Biennial (1x/every 2 years)
RCRA	Monitor groundwater quality and water levels upgradient and downgradient of the PLF and the OLF	10	Quarterly (4x/year)
Treatment System ^{a, b}	Monitor quality of groundwater treatment system influent, effluent, and downgradient surface water	9	Semiannual (2x/year)
Surface-Water Support ^a	Monitor quality of surface water downgradient of contaminant plume	2	Semiannual (2x/year)

^aTreatment system and surface-water support locations are not monitoring wells but are included for completeness.

^bThe PLFIS is not considered part of the groundwater monitoring network, and is discussed separately.

Table 3-82 presents the full 2007 schedule for RFLMA groundwater sample collection, a subset of which is summarized in Table 3-83 as those scheduled samples that were not successfully collected (e.g., due to dry conditions). Corresponding analytical results are published in the associated quarterly reports (DOE 2007g, 2007h, 2008a) and Appendix B.

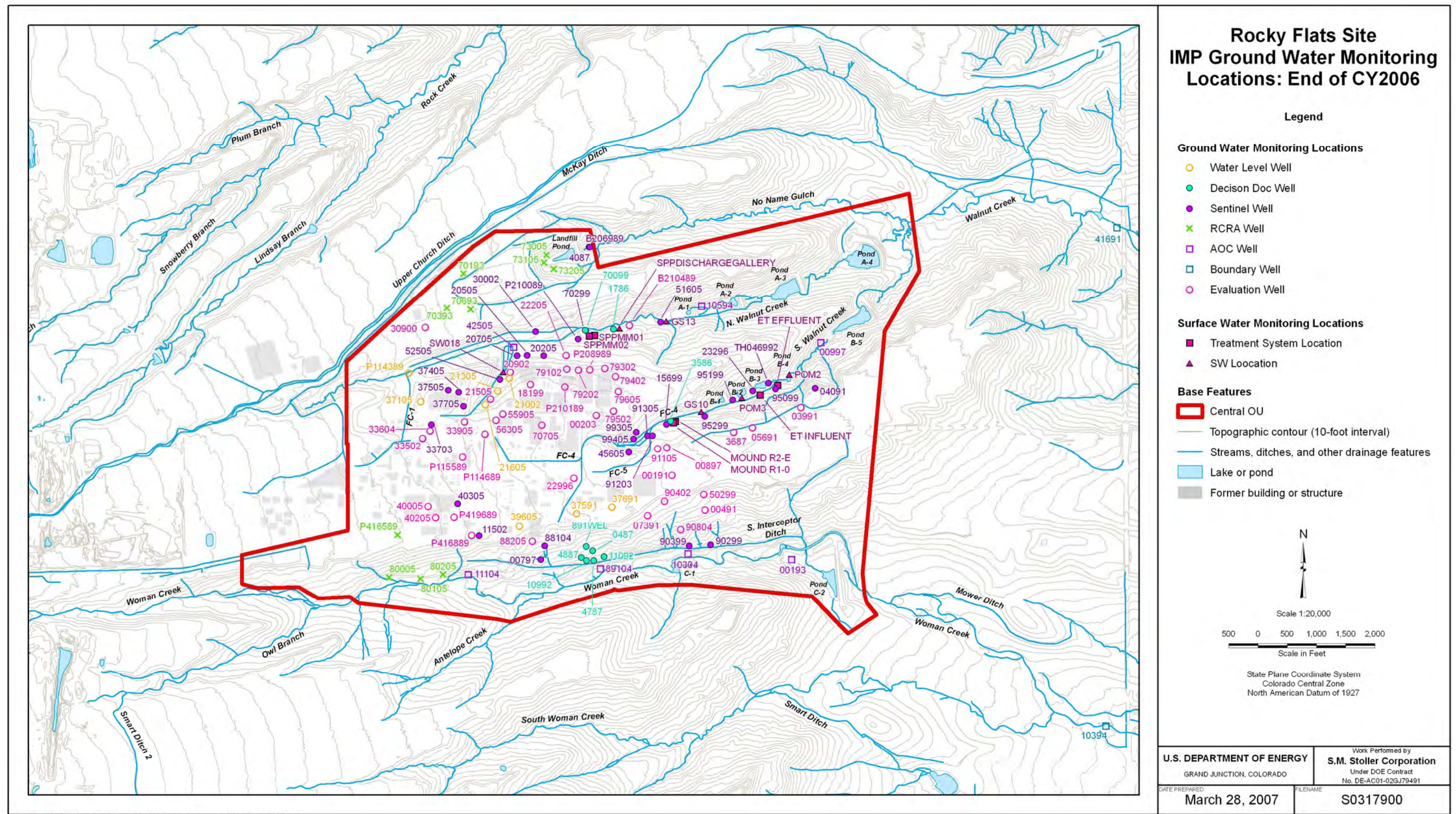


Figure 3-202. Rocky Flats Site IMP Groundwater Monitoring Locations: End of CY 2006

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Table 3-82. Summary of Scheduled RFLMA-Required Groundwater Sampling in CY 2007 (by Quarter)

Location		Analytes					
ID	Location Classification	VOCs	U	Nitrate	Metals	Pu/Am	SVOCs
0487 ^a	DD	1					
4087	AOC	2,4	2,4	2,4			
00193	AOC	2,4	2,4				
00797	S	2,4	2,4				
00997	AOC	2,4	2,4	2,4			
04091	S	2,4					
10304	AOC	2,4	2,4	2,4			
10394	B	2	2	2			
10594	AOC	2,4	2,4	2,4			
11104	AOC	2,4	2,4				
11502	S	2,4	2,4				
15699	S	2,4					
20205	S	2,4	2,4			2,4	
20505	S	2,4	2,4			2,4	
20705	S	2,4	2,4	2,4		2,4	
23296	S	2,4	2,4				
30002	S	2,4					
33703	S	2,4					
37405	S	2,4	2,4	2,4		2,4	
37505	S	2,4	2,4	2,4			
37705	S	2,4	2,4	2,4		2,4	
40305	S	2,4	2,4				
41691	B	2	2	2			
42505	AOC	2,4					
45605	S	2,4					
52505	S	2,4					
70099	S		2,4	2,4			
70193	RCRA	1,2,3,4			1,2,3,4		
70393	RCRA	1,2,3,4			1,2,3,4		
70693	RCRA	1,2,3,4			1,2,3,4		
73005	RCRA	1,2,3,4			1,2,3,4		
73105	RCRA	1,2,3,4			1,2,3,4		
73205	RCRA	1,2,3,4			1,2,3,4		
80005	RCRA	1,2,3,4			1,2,3,4		1,2,3,4
80105	RCRA	1,2,3,4			1,2,3,4		1,2,3,4
80205	RCRA	1,2,3,4			1,2,3,4		1,2,3,4
88104	S	2,4	2,4				
89104	AOC	2,4					
891WEL ^a	E	1					
90299	S	2,4					
90399	S	2,4					
91203	S	2,4					
91305	S	2,4	2,4	2,4			
95099	S	2,4					
95199	S	2,4					
95299	S	2,4					
99305	S	2,4	2,4	2,4			

Table 3-82 (continued). Summary of Scheduled RFLMA-Required Groundwater Sampling in CY 2007 (by Quarter)

Location		Analytes					
ID	Location Classification	VOCs	U	Nitrate	Metals	Pu/Am	SVOCs
99405	S	2,4	2,4	2,4			
B206989	AOC	2,4	2,4	2,4			
P210089	S	2,4	2,4	2,4			
P416589	RCRA	1,2,3,4			1,2,3,4		1,2,3,4
TH046992	S	2,4					
MOUND R1-0	TS	2,4					
MOUND R2-E	TS	2,4					
GS10	TS	2,4					
ET INFLUENT	TS	2,4					
ET EFFLUENT	TS	2,4					
POM2	TS	2,4					
SPPMM01	TS		2,4	2,4			
SPIN	TS		2,4	2,4			
GS13	TS		2,4	2,4			
SW018	SS	2,4					

Notes: ^aDuring first quarter CY 2007, prior to the signing of RFLMA on March 14, groundwater sampling was conducted in accordance with the 2006 IMP (DOE 2006c, 2006d). Groundwater samples were collected from OU 1 wells 891WEL and 0487 during the first quarter, which would not have occurred had RFLMA been in place at that time: under RFLMA, well 891WEL is now sampled biennially as an Evaluation well and sampling at well 0487 was discontinued. ID = Identification (name) of well/sampling location
Location classifications: AOC = Area of Concern, B = Boundary, S = Sentinel, DD = Decision Document, E = Evaluation, RCRA = Resource Conservation and Recovery Act, TS = Treatment System, and SS = Surface Water Support
SVOCs = semivolatile organic compounds
2 (or other numeral) = Analyte requested for that quarter; if blank, analyte not requested

Table 3-83. Summary of Groundwater Samples Not Successfully Collected in 2007

Location		Analytes						Comments
ID	Classification	VOCs	U	Nitrate	Metals	Pu/Am	SVOCs	
4087	AOC	4	4	4				Dry well
90299	S	4						Dry well
95299	S	2, 4						Dry well
P210089	S	2						Sample for VOCs successfully collected in third quarter.

Notes: ID = Identification (name) of well/sampling location
RFLMA classifications: AOC = Area of Concern, B = Boundary, S = Sentinel, E = Evaluation, RCRA = Resource Conservation and Recovery Act, TS = Treatment System, SS = Surface Water Support
SVOCs = semivolatile organic compounds
2 (or other numeral) = Analyte requested; if blank, analyte not requested

3.1.5.2 Non-RFLMA Groundwater Monitoring Activities of 2007

Non-RFLMA (a.k.a. nonroutine) groundwater monitoring was performed in 2007 in support of several data needs, which generally fall within the following two categories:

- Investigative sampling; and
- Performance sampling.

Table 3-84 summarizes all non-RFLMA sample collection performed in 2007. In addition to this non-RFLMA sampling, additional non-RFLMA monitoring was performed through the Site-wide measurement of water levels as discussed in Section 3.1.3.5.

Table 3-84. Summary of Non-RFLMA Groundwater Monitoring Performed in 2007

Location		Analytes ^a				
ID	Classification	VOCs	U	U Isotopes	Nitrate	$\alpha/\beta/\gamma$
00191 ^b	E	2				
07391 ^b	E	2	2			
10594	AOC		3	3		3
18199 ^b	E	2				
33502 ^b	E	2				
33604 ^b	E	2				
45605	S	1				
51605 ^b	E		2		2	
80205	RCRA		3	3		3
91105 ^b	E	2				
99405	S		3	3		3
MOUND R1-0	TS	3,4 (4)				
MOUND R2-E	TS	3,4 (4)				
GS10	TS	3 (2)				
ET INFLUENT	TS	3,4 (2)				
ET EFFLUENT	TS	3,4 (2)				
SPIN	TS		1,2,3 (10)		1,2,3 (10)	
SPPMM01	TS		1,2,3 (10)		1,2,3 (10)	
SPP DIS GAL ^c	TS		1,2,3,4 (14)	3	1,2,3,4 (15)	3,4 (2)
GS13	TS		1,2 (9)		1,2,4 (10)	4

Notes: ^aFor those locations where more than one non-RFLMA-required sample was collected, the total number of non-RFLMA samples collected in 2007 is indicated in parentheses.

^bSamples from these Evaluation wells are normally collected biennially (i.e., every other year, during even-numbered years).

^cThe Solar Ponds Plume Discharge Gallery (SPP DIS GAL, a.k.a. SPP DG) is sampled in accordance with the RFSOG (DOE 2007f).

ID = Identification (name) of well/sampling location

RFLMA classifications: AOC = Area of Concern; B = Boundary; S = Sentinel; E = Evaluation; RCRA = Resource Conservation and Recovery Act; TS = Treatment System; and SS = Surface Water Support

$\alpha/\beta/\gamma$ = gross alpha, gross beta, and in some cases gross gamma

2 (or other numeral) = Quarter in which analyte was requested; if blank, analyte not requested

Investigative sampling may be performed when additional data needs are identified that may not be satisfied by the routine monitoring schedule. In 2007, as in the prior year, this was applicable to the SPPTS. Following plumbing repairs made in 2006 (DOE 2007e), samples were collected on an increased frequency from locations supporting the SPPTS, including SPIN, SPPMM01, SPP DG (a non-RFLMA location), and GS13. This “extra” sampling, which focused on nitrate and U concentrations, continued into third quarter CY 2007, at which point it was determined that the plumbing repairs had been successful in restoring water treatment. The SPPTS is discussed in greater detail in Section 3.1.2.10.

Investigative sampling was also performed via the continuation of the no-purge sampling evaluation begun in late 2005 (see DOE 2007e for additional discussion). This topic is addressed in Section 3.1.5.4.

Another application of investigative sampling was the collection of samples from select groundwater and surface-water monitoring locations for the determination of U isotope signature. This effort was conducted in part to support negotiations with the Colorado WQCC on the site-specific U standard, which the Site is requesting be eliminated in favor of the State-wide standard. These negotiations are discussed in greater detail in Section 2.3.

No Evaluation wells were scheduled for RFLMA sampling in 2007; however, several wells were sampled for investigative reasons, for example to evaluate the effects of nearby remediations on water quality. Wells sampled for this investigative sampling are listed in Table 3-85. Not included in this table is well 891WEL, which was sampled in the first quarter as a “Decision Document” well under the IMP (DOE 2006c, 2006d) and was subsequently reclassified as an Evaluation well through the signing of RFLMA (DOE 2007d). Results of this sampling are discussed in the text on the associated plumes (Section 3.1.5.3).

Table 3-85 Investigative Sampling of Evaluation Wells in 2007

Location	General Area	Reason for Sampling
00191	903 Pad	Collect additional data near VOC source area where HRC was inserted
07391	Ryan's Pit	Collect additional data near VOC source area where source was removed and HRC was inserted
18199	IHSS 118.1 (Carbon Tetrachloride Plume)	Collect additional data near VOC source area where source was removed and HRC was inserted
33502	VC Plume	Collect additional data near VOC source area following removal of overlying impermeable surfaces
33604	VC Plume	Collect additional data near VOC source area following removal of overlying impermeable surfaces
51605	North Walnut Creek	Collect additional data following repair of SPPTS (located upgradient of this well)
91105	OBP #2	Collect additional data near VOC source area where source was removed and HRC was inserted

HRC= Hydrogen Release Compound®

Performance sampling was conducted to evaluate groundwater treatment system maintenance activities on effluent water quality. During system upgrades in 2006, in which automated instrumentation was installed and plumbing was upgraded at the MSPTS and ETPTS, the plumbing at each treatment cell was updated to allow either downflow (water enters at the top of the cell and exits at the bottom—the original configuration of these systems) or upflow (water enters at the bottom and exits at the top) configurations. An upflow configuration can be more effective in some settings, as preferential flowpaths may not develop as readily. To determine whether the direction of flow has a significant influence on effluent water quality at the MSPTS and ETPTS, the flow direction was changed for both cells at each system and samples were collected after the systems had been allowed to equilibrate to these conditions. Results did not indicate any significant change in water quality, but there was a sharp increase in the maintenance required. See Section 2.6 for maintenance information.

3.1.5.3 Groundwater at the RFS: Discussion and Interpretations

This section presents a summary evaluation of groundwater quality and flow at the RFS during 2007. Groundwater quality is addressed first, followed by interpretations of groundwater flow; descriptions of special studies and activities concludes the section. Included in the discussion of water quality are descriptions of the behavior of and any notable activities at the groundwater treatment systems during 2007.

Trend Plots

Numerous statistical trend plots were constructed using analytical data collected from AOC, Boundary, Sentinel, and RCRA wells as part of this report. These are presented in Appendix B.3. Plots were also constructed for locations associated with the SPPTS, and are discussed later in this section.

The Sanitas™ software package (version 8.7; Sanitas Technologies 2007) was used for statistical calculations, including the construction of trend plots. (This is noted for the purpose of completeness only; this report does not make any software recommendations.) For simplicity, because the fundamental objective of AOC, Boundary, and Sentinel wells is related to detection monitoring, and because no interwell statistics were planned for these classes of wells (only intrawell assessment of the trend of an analyte over time at each given well), all wells were assigned downgradient positions. Only RCRA wells were assigned either upgradient or downgradient positions to support the related statistical evaluations, as described in Section 3.1.2.8 and Section 3.1.2.9.

Analytical data were handled as described in Section 3.1.1.2. Trends were calculated and plotted using the S-K statistical method, as recommended for Rocky Flats groundwater data (K-H 2004d) and in accordance with the RFSOG (DOE 2007f). Trends were only plotted where they were calculated to be at least 80 percent significant.

Table 3-86 summarizes the results of S-K trend plot calculations performed for AOC, Boundary, Sentinel, and RCRA wells. Only increasing and decreasing trends calculated to be at least 80 percent significant are included in this table. (Therefore, even if 95 percent significant, trends with zero slope are not included.) Additionally, only those groundwater monitoring well classifications scheduled for routine monitoring per RFLMA are included; this means Evaluation wells are omitted. Evaluation wells will next be scheduled for routine monitoring in 2008. Refer to Appendix B.3 for the plots and associated summary tables, and Figure 3-202 for well locations. Significant trends for select analytes and locations are discussed later in this section in the context of their respective groundwater contaminant plumes.

Table 3-86. Summary of S-K Trend Calculations

Well	General Location	Analyte	Trend	Significant at 95%?
<i>AOC Wells</i>				
00997	Pond B-5	Uranium	Increasing	No
<i>Boundary Wells</i>				
41691	Walnut Creek/Indiana Street	Nitrate	Increasing	No
41691	Walnut Creek/Indiana Street	Uranium	Increasing	Yes
10394	Woman Creek/Indiana Street	Uranium	Decreasing	Yes

Table 3-86 (continued). Summary of S-K Trend Calculations

Well	General Location	Analyte	Trend	Significant at 95%?
Sentinel Wells				
15699	MSPTS	1,1,1-TCA	Decreasing	No
91203	OBP #2	1,1,1-TCA	Increasing	No
20505	B771	1,1-DCE	Increasing	No
90399	903 Pad/Ryan's Pit Plume-SID	1,1-DCE	Increasing	No
91203	OBP #2	1,1-DCE	Increasing	No
15699	MSPTS	1,2-DCA	Increasing	No
33703	OBP#1	1,3-DCB	Increasing	No
33703	OBP#1	1,4-DCB	Increasing	Yes
04091	East Trenches Plume	Carbon tet	Decreasing	Yes*
23296	ETPTS	Carbon tet	Decreasing	Yes
90299	903 Pad/Ryan's Pit Plume-SID	Carbon tet	Decreasing	Yes*
90399	903 Pad/Ryan's Pit Plume-SID	Carbon tet	Decreasing	No
33703	OBP#1	Chlorobenzene	Decreasing	Yes
15699	MSPTS	Chloroform	Decreasing	Yes*
23296	ETPTS	Chloroform	Decreasing	Yes
90299	903 Pad/Ryan's Pit Plume-SID	Chloroform	Decreasing	No
20705	B771	Cis-1,2-DCE	Increasing	Yes*
23296	ETPTS	Cis-1,2-DCE	Increasing	Yes
33703	OBP#1	Cis-1,2-DCE	Increasing	No
91203	OBP #2	Cis-1,2-DCE	Increasing	Yes*
99305	B991	Cis-1,2-DCE	Increasing	Yes
99405	B991	Cis-1,2-DCE	Increasing	No
TH046992	ETPTS	Cis-1,2-DCE	Increasing	Yes*
04091	East Trenches Plume	PCE	Decreasing	No
15699	MSPTS	PCE	Decreasing	No
23296	ETPTS	PCE	Decreasing	Yes
91203	OBP #2	PCE	Increasing	No
95199	ETPTS	PCE	Increasing	No
99305	B991	PCE	Increasing	No
99405	B991	PCE	Increasing	Yes*
15699	MSPTS	Trans-1,2-DCE	Increasing	Yes*
33703	OBP#1	Trans-1,2-DCE	Increasing	No
15699	MSPTS	TCE	Decreasing	No
23296	ETPTS	TCE	Decreasing	No
90299	903 Pad/Ryan's Pit Plume-SID	TCE	Decreasing	Yes
91203	OBP #2	TCE	Increasing	No
95199	ETPTS	TCE	Increasing	No
99405	B991	TCE	Increasing	Yes*
15699	MSPTS	VC	Increasing	Yes*
20705	B771	VC	Increasing	No
00797	B881	Uranium	Increasing	Yes
20705	B771	Uranium	Increasing	Yes**
37505	B371	Uranium	Increasing	No
40305	B444	Uranium	Increasing	No
88104	B881	Uranium	Decreasing	Yes**
99305	B991	Uranium	Increasing	Yes
99405	B991	Uranium	Decreasing	No
37705	B371	Nitrate	Increasing	Yes*

Table 3–86 (continued). Summary of S-K Trend Calculations

Well	General Location	Analyte	Trend	Significant at 95%?
70099	SPPTS	Nitrate	Decreasing	Yes
99305	B991	Nitrate	Decreasing	No
20705	B771	Am-241	Decreasing	No
RCRA Wells				
70393	PLF	1,1,1-TCA	Decreasing	Yes
70393	PLF	1,1-DCE	Decreasing	Yes
70393	PLF	PCE	Decreasing	Yes
70393	PLF	TCE	Decreasing	Yes
70193	PLF	Se	Decreasing	No
70193	PLF	U	Decreasing	No

Notes: Only increasing and decreasing trends are included; indeterminate and zero-slope trends are not. Trends are listed if there is an 80 percent statistical significance; any decisions that may be made would be based on trends having a 95 percent significance. Bold entries designate those trends having a 95 percent significance. Of the RCRA well networks, only upgradient PLF members are represented by sufficient data for trending. Evaluation wells are not included because they were not scheduled for RFLMA biennial sampling in 2007.

DCA = dichloroethane; DCE = dichloroethene; DCB = dichlorobenzene

*Although the trend is calculated to have a 95 percent significance, 25 percent or more of the analytical data used to calculate this trend are nondetects. See Section 3.1.1.2 for discussion of how nondetects were handled in trending calculations.

**Although the trend is calculated to have a 95 percent significance, the data used to calculate this trend may be affected by well replacement. Results for this constituent from the original well are markedly different from those from the replacement well. These data sets may be separated in the future, rather than continue to be pooled, as additional data are collected from the replacement well and are sufficient for trending separately.

Additional data will be collected in accordance with RFLMA, and will further refine the trend plots. Given that most of the analytical data used in the trend calculations were collected before the Site was closed and in many cases are from wells that have since been replaced, some change in slope is to be expected as the hydrologic and geochemical systems stabilize. For a cross-walk of original and replacement wells, refer to the 2006 IMP (DOE 2006c: Appendix B, Table B-4).

Groundwater Plumes with Treatment Systems

Groundwater-quality data were obtained for all monitored areas in 2007. Analytical data have been published in quarterly reports issued for 2007 (DOE 2007g, 2007h, 2008a), plus Appendix B.6, and will not be duplicated here. Appendix B.3 includes the S-K trend plots that were contained within those documents as well as S-K trend plots for fourth quarter CY 2007.

Groundwater quality at the Site in 2007 was largely consistent with data reported in prior years. Groundwater plumes that were identified and characterized through the decades of pre-closure groundwater monitoring at the Site do not appear to have been greatly affected during 2007 by closure of the Site.

It bears repeating that the reduction in size and density of the post-closure groundwater monitoring network compared to that operating prior to Site closure does not permit the assessment of small-scale changes in plume configuration, nor in many other local-scale attributes. This is consistent with the vision and design of the closure network, which was never intended to provide the level of detail afforded by the extremely dense well network existing in past years.

This section describes the general groundwater quality in various areas of interest across the Site. Descriptions of activities and conditions in 2007 at the three main groundwater contaminant plume treatment systems (MSPTS, ETPTS, and SPPTS) are also provided.

Mound Plume and Treatment System

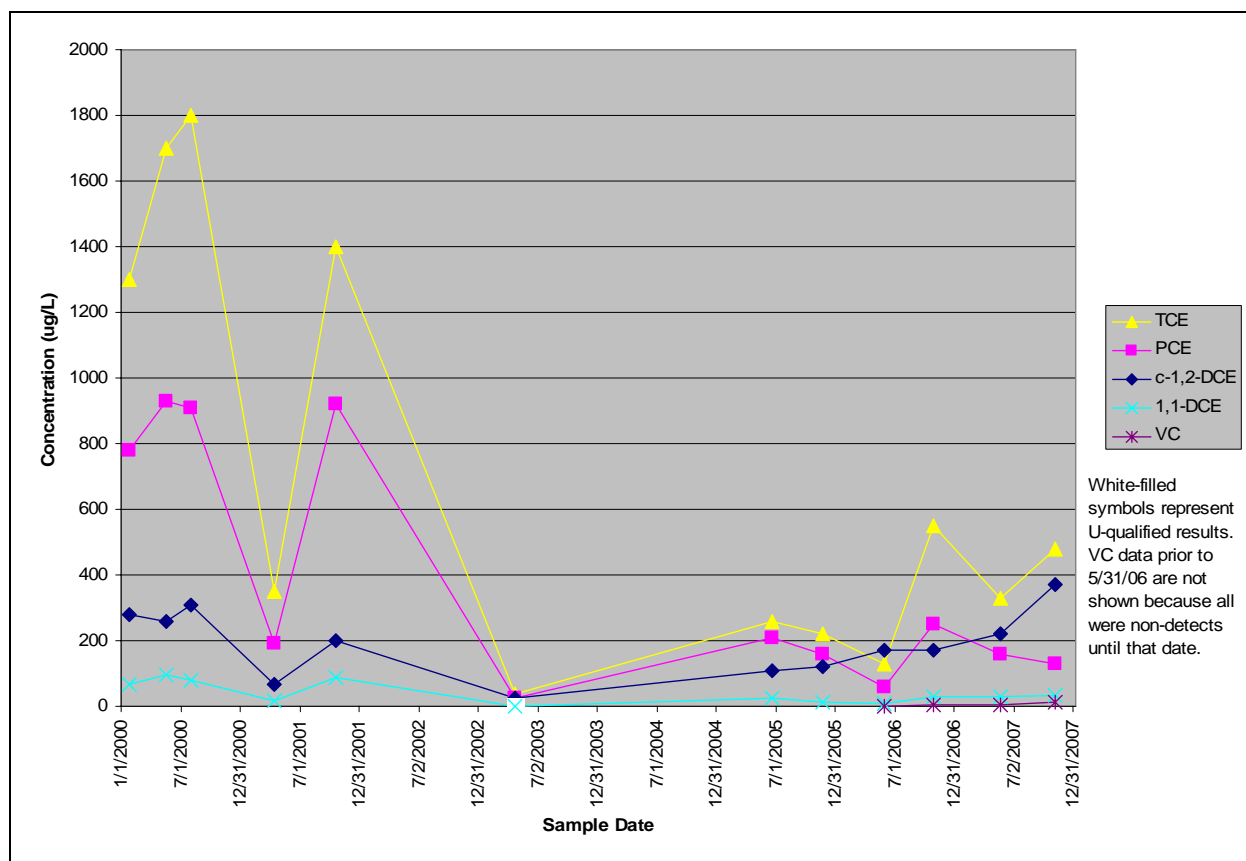
The Mound Plume (a.k.a. Mound Site Plume) is located north of the former 903 Pad. The source of the plume is a former drum storage area (“the Mound”) that was in use in the 1950s. Some of the drums leaked, creating a groundwater contaminant plume extending north toward South Walnut Creek. The drums were removed in 1970, and contaminated soils were removed in 1997. The following paragraphs describe the plume and treatment system installed to address the groundwater contamination.

Mound Plume

The Mound Plume is characterized by elevated concentrations of PCE and TCE. The source area is very near OBP #2, source of another VOC plume, which is discussed separately below. Note, however, that flow from the OBP #2 source area is also captured and treated by the MSPTS, and has been since 2005.

No groundwater sample was collected from Evaluation well 00897 in 2007. Figure 3-203 displays concentrations of PCE, TCE, cis-1,2-dichloroethene (DCE), 1,1-DCE, and VC in samples from downgradient Sentinel well 15699. (Refer to DOE 2007g, 2007h, 2008a, and Appendix B.6 for additional analytical data from 2007.) As noted in the 2006 annual report (DOE 2007e), the concentrations of these constituents are correlated; for most data collected since 2000, the relative concentration of each mirrors its position in the degradation pathway of PCE. (With successive dechlorination, PCE is transformed to TCE and then to cis-1,2-DCE, 1,1-DCE, and VC [K-H 2004a].) With more active biodegradation of chlorinated solvents in the Mound Plume, one would expect to see a relative increase of daughter products and a corresponding decrease in concentrations of parent products. Indeed, data collected in 2007 suggest there is an increase in biodegradation, with concentrations of cis-1,2-DCE and VC increasing markedly since closure.

As discussed in the 2006 report (DOE 2007e) and confirmed with current data (see below), concentrations of these compounds have also increased sharply at the MSPTS. This increase has been attributed to the application of Hydrogen Release Compound[®] (HRC) in backfill of the remediated OBP #2 source area, with the HRC stimulating biodegradation of residual VOCs in the subsurface. This mechanism may also be the cause of increased daughter products reported in groundwater samples collected from well 15699. The additional volume represented by groundwater from the OBP #2 Plume that is now directed to the MSPTS (i.e., transported to the system by the backfilled storm drain) may increase the amount of groundwater infiltrating the walls and floor of the intercept trench associated with that treatment system. Samples from well 15699, located downgradient of that trench, may be reflecting the addition of OBP #2 water with its higher concentration of daughter products than is typical in Mound Plume groundwater.



Notes: RFLMA surface-water action levels for these constituents (µg/L; DOE 2007d, Attachment 2, Table 1): PCE, 5; TCE, 5; cis-1,2-DCE, 70; 1,1-DCE, 7; VC, 0.2. Several results are qualified (J, D), but are not shown differently for the sake of simplicity.

Figure 3-203. VOC Concentrations in Samples from Sentinel Well 15699

S-K trend plots for well 15699 (see Appendix B.3, as well as Section 3.1.2.5 and Table 3-86) show a statistically significant (95 percent) decreasing trend for chloroform and similarly significant increasing trends in trans-1,2-DCE and VC concentrations. However, the two increasing trends may not be real, because most of the data for this well since 2000 for these constituents are reported as nondetects with elevated detection limits (e.g., 100 µg/L).

Mound Site Plume Treatment System

The MSPTS was the first groundwater intercept/treatment system installed at the Site to incorporate zero-valent iron (ZVI), and is actually among the first of its type in the world. This work was completed in 1998.

Routine maintenance activities performed at the MSPTS in 2007 are discussed in Section 2.6.1. No crust has yet been observed as this media was installed in the summer of 2006.

Flow rates through the MSPTS have remained well above pre-2005 levels due to the routing of groundwater flow through the backfilled storm-drain corridor and into the MSPTS intercept trench. (For additional background, see the 2005 Annual Report, DOE 2006e.) The total volume of water treated by the MSPTS during 2007 is estimated at approximately 326,000 gallons. This reflects an apparent decrease relative to the volume treated in 2005 and 2006, but still a several-

fold increase over the estimated volumes treated in most years prior to closure. Table 3-87 provides annual estimates of the volume of water treated by the MSPTS, and Figure 3-204 presents the corresponding hydrograph. Figure 3-205 provides a hydrograph for CY 2007.

Table 3-87. Estimated Volumes of Water Treated by the MSPTS

Calendar Year	Annual Estimates of Volume Treated (gallons)	Estimated Cumulative Volume Treated (gallons)
2000	258,000	660,000
2001	119,000	780,300
2002	53,000	833,000
2003	82,000	915,000
2004	86,000	1,001,000
2005	506,000	1,507,000
2006	430,000	1,937,000
2007	326,000	2,263,000

Note: Estimates for years 2000 through 2004 are compiled from K-H (2000a, 2000b, 2000c, 2000d, 2001a, 2003, 2005a, 2005f).

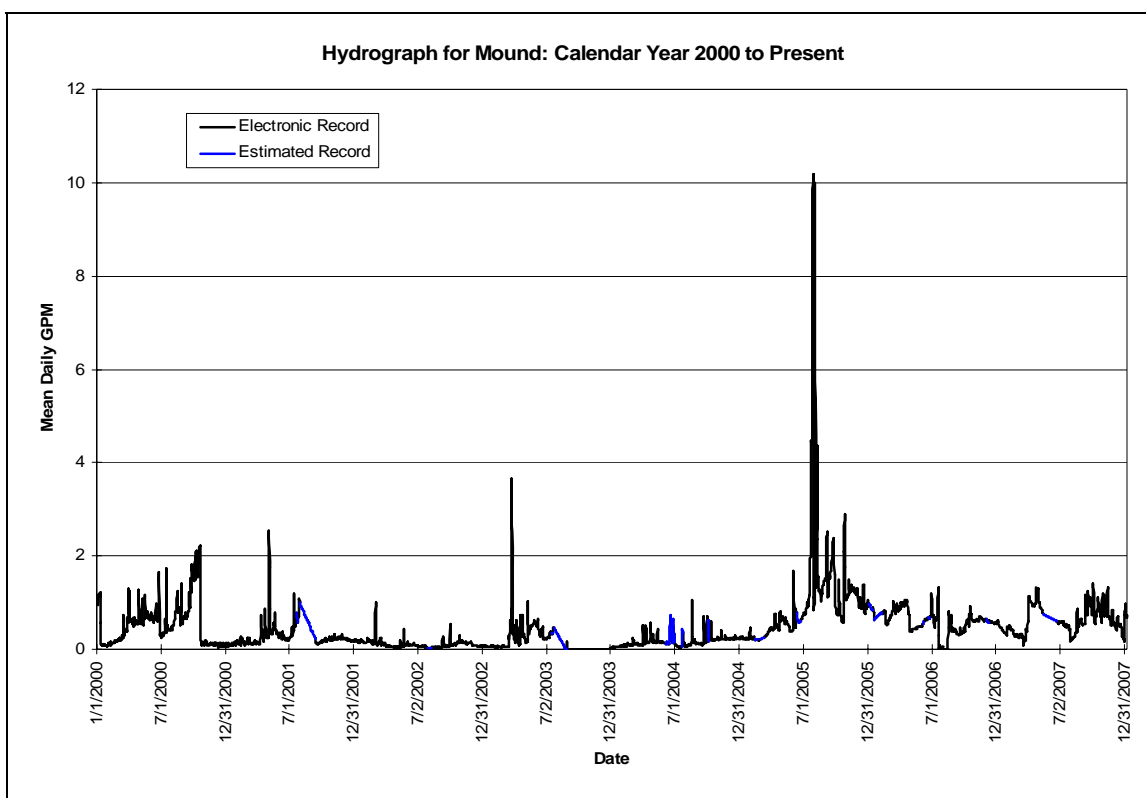


Figure 3-204. Hydrograph for MSPTS Since 2000

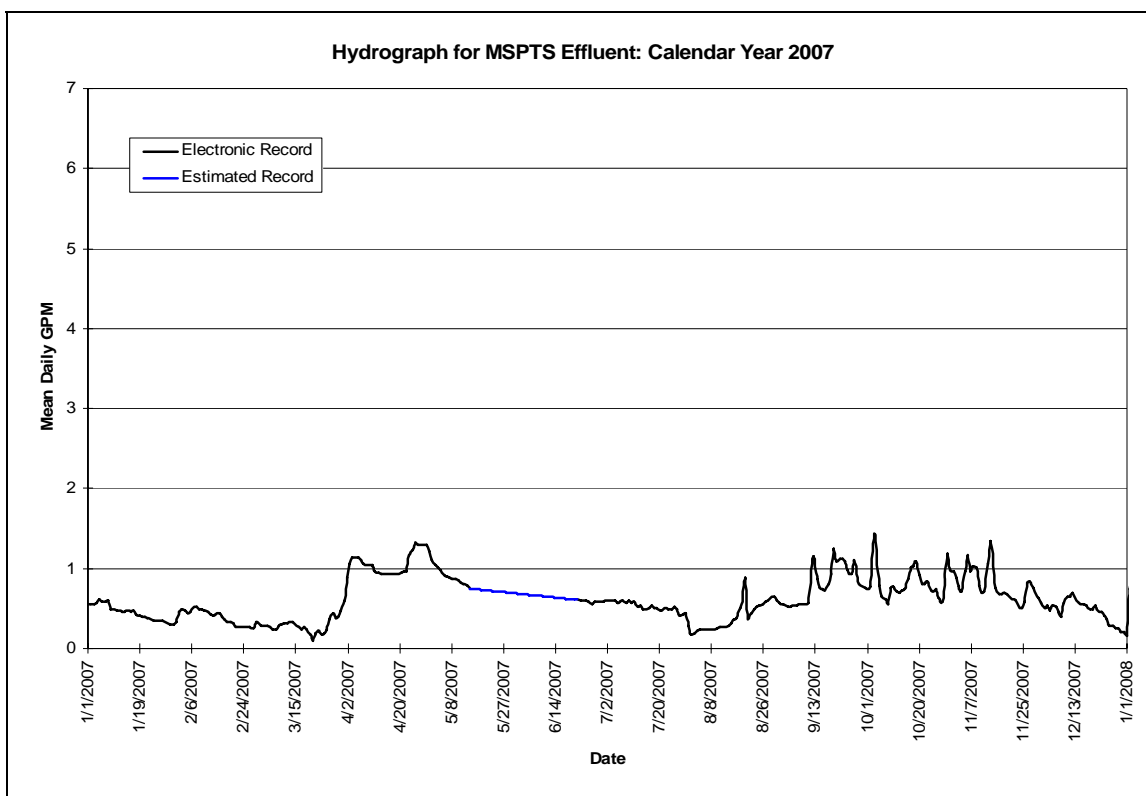


Figure 3-205. Hydrograph for MSPTS for CY 2007

As described for the MSPTS and ETPTS in the 2006 annual report (DOE 2007e), the plumbing at the treatment cells was upgraded that summer to provide an upflow condition within each cell (i.e., such that the influent water would enter each cell at the bottom, move upward through the media, and exit at the top of the cell, rather than the reverse). Flow direction was changed to upflow on September 12, 2007, to assess whether treatment effectiveness varied significantly under different flow conditions. Samples were collected on two occasions: approximately 1 and 2 months after the flow direction was changed. Results indicated no obvious, meaningful differences between the two flow regimes. However, because of the sharp increase in maintenance required while the MSPTS was operating under upflow conditions, the system was returned to downflow on January 17, 2008. (Maintenance was increased because the filter between the two cells kept plugging, as fine-grained, iron-based particles in the uppermost portion of the media were mobilized and trapped by the filter. As a result, the filter had to be flushed up to twice weekly; when operating in the downflow configuration, there is rarely a need to do this.)

The MSPTS was sampled six times in 2007: once each in June and July, twice in August, and once each in October and November. The June and November samples were collected in accordance with RFLMA, while the other samples were collected as performance checks and to assess upflow versus downflow conditions as described above.

In 2007, eight VOCs were detected in MSPTS influent at concentrations exceeding their respective Table 1 levels (DOE 2007d): 1,1,1-trichloroethane (TCA), 1,1-DCE, carbon

tetrachloride, chloroform, cis-1,2-DCE, PCE, TCE, and VC. Worth noting is the fact that 1,1,1-TCA had not been detected in MSPTS influent at these levels (i.e., above 200 µg/L) until July 2007, and was one of the primary contaminants detected in groundwater from the pre-remediated OBP #2. Its presence in MSPTS influent illustrates the effectiveness of the connection of the preferential pathway formed by the backfilled storm drain corridor (which transports groundwater from the OBP #2 area) to the MSPTS intercept trench.

Three VOCs were detected in MSPTS treated effluent in 2007 at concentrations exceeding RFLMA Table 1 values: cis-1,2-DCE, methylene chloride, and VC. These represent some of the more recalcitrant compounds, hence their presence in effluent even after the media replacement in 2006. These results are generally consistent with conditions reported in 2006 (DOE 2007e). As discussed below, this is also true of conditions at surface-water performance monitoring location GS10, which reported detections of VOCs but no exceedances of RFLMA Table 1 values.

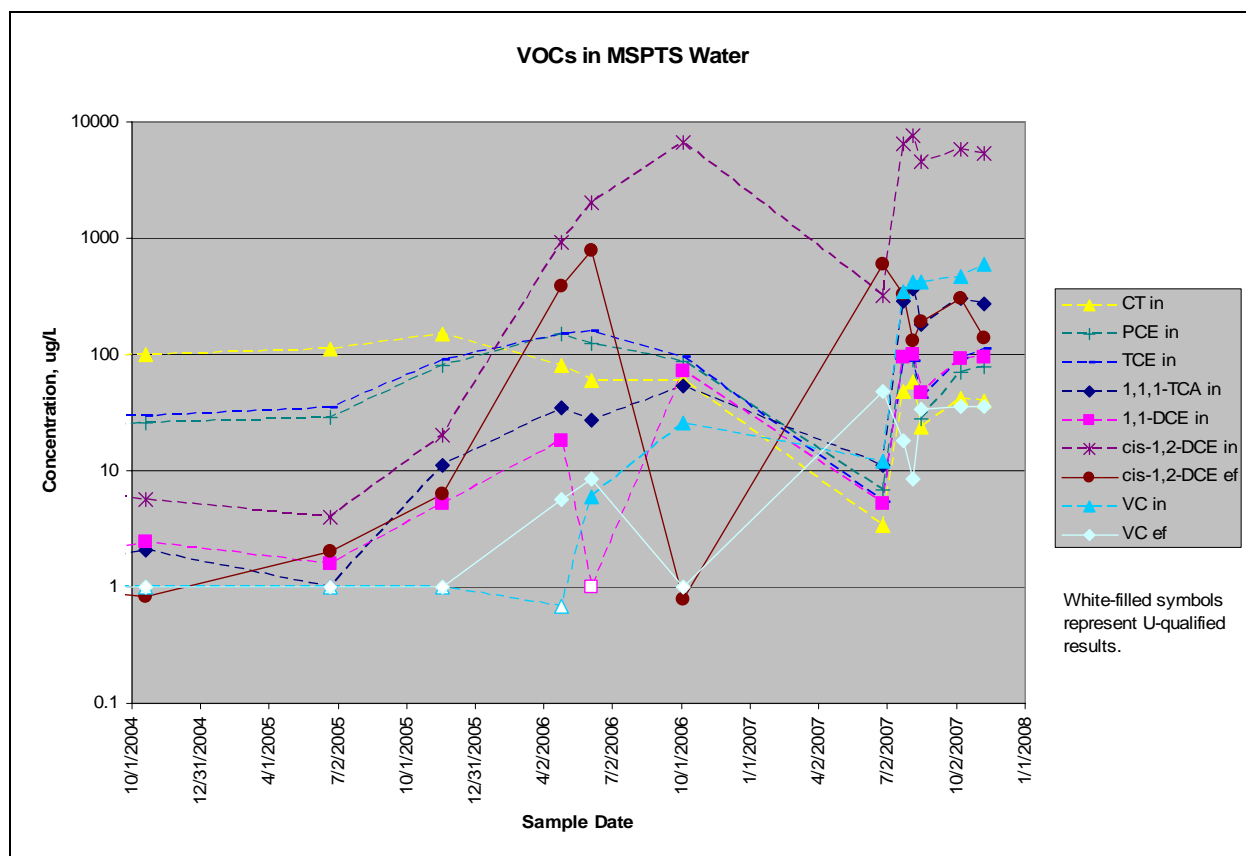
Table 3-88 summarizes MSPTS influent and effluent data. Refer to the quarterly reports (DOE 2007g, 2007h, 2008a) and Appendix B.6 for additional water-quality data for the MSPTS. Data for samples of MSPTS influent show the influence of closure activities performed upgradient of the system. As discussed in previous annual reports (DOE 2006e, 2007e), a preferential pathway (backfilled storm drain corridor) now routes groundwater impacted by the OBP #2 into the MSPTS groundwater intercept trench. Because the source area was remediated and HRC was added to the backfill to stimulate biodegradation of residual VOCs, the concentrations of daughter products cis-1,2-DCE, 1,1-DCE, and VC in MSPTS influent have increased.

Figure 3-206 illustrates how concentrations of some primary VOCs in MSPTS influent and effluent have been affected by these closure activities. This figure encompasses the period from immediately prior to the OBP #2 remediation to the end of 2007. As shown, the concentration of carbon tetrachloride has decreased over this period, while concentrations of PCE, TCE, 1,1,1-TCA, and daughter products from these constituents (1,1-DCE, cis-1,2-DCE, and VC) have increased. This is interpreted to be a reflection of the increased volume of water reaching the MSPTS from the OBP #2 area, relative to the volume of flow from this area reaching the MSPTS prior to remediation of that source area.

Table 3-88. Select VOC Data (µg/L) from MSPTS Influent and Effluent

Date	1,1,1-TCA		1,1-DCE		CT		CF		cis-1,2-DCE		MCI		PCE		TCE		VC	
	R1-0	R2-E	R1-0	R2-E	R1-0	R2-E	R1-0	R2-E	R1-0	R2-E	R1-0	R2-E	R1-0	R2-E	R1-0	R2-E	R1-0	R2-E
1/27/00	8 (J)	1 (U)	10	1 (U)	110	1 (U)	25	1 (U)	57	1	5 (BJ)	1 (B)	120	0.1 (J)	150	1 (U)	10 (U)	1 (U)
2/8/00	9 (J)	1 (U)	10	1 (U)	110	1 (U)	25	1 (U)	59	2	6 (JB)	2 (B)	96	1 (U)	140	1 (U)	10 (U)	0.1 (J)
3/7/00	9 (J)	1 (U)	12	1 (U)	110	1 (U)	26	1 (U)	62	2	14 (B)	0.9 (JB)	100	1 (U)	160	1 (U)	10 (U)	1 (U)
4/26/00	7 (J)	1 (U)	10	1 (U)	96	1 (U)	24	1 (U)	61	4	20 (B)	0.8 (JB)	110	1 (U)	140	1 (U)	10 (U)	0.2 (J)
5/15/00	6	1 (U)	8	1 (U)	49 (D)	1 (U)	19	1 (U)	42 (D)	3	0.1 (JB)	0.7 (BJ)	68 (D)	1 (U)	87 (D)	1 (U)	0.3 (J)	1 (U)
6/14/00	8	1 (U)	10	1 (U)	130	1 (U)	24	1 (U)	42	1	3 (BJ)	0.2 (BJ)	130	1 (U)	150	1 (U)	10 (U)	1 (U)
7/19/00	4 (J)	1 (U)	6	1 (U)	63	1 (U)	12	1 (U)	42	2	4 (JB)	0.9 (JB)	64	1 (U)	79	1 (U)	5 (U)	1 (U)
8/16/00	10 (J)	1 (U)	10 (J)	1	180	1 (U)	31	1 (U)	39	1 (J)	23 (B)	0.3 (BJ)	100	1 (U)	140	1 (U)	10 (U)	1 (U)
9/13/00	5.9	0.5 (U)	7	0.5 (U)	122	0.5 (U)	25.4	0.5 (U)	32.1	0.74	1 (U)	0.57	65.3	0.5 (U)	99.9	0.5 (U)	1 (U)	0.5 (U)
10/25/00	6.3	0.5 (U)	8	0.5 (U)	133	0.5 (U)	25.6	0.5 (U)	37.3	0.69	1 (U)	0.5 (U)	68.7	0.33 (J)	104	0.5 (U)	1 (U)	0.5 (U)
4/19/01	4 (D)	1 (U)	5 (D)	1 (U)	73 (D)	1 (U)	20 (D)	0.6 (J)	38 (D)	3	2 (U)	6	44 (D)	1 (U)	76 (D)	1 (U)	2 (U)	1 (U)
10/25/01	3.4	1 (U)	5.1	1 (U)	130	1 (U)	23	1 (U)	23	0.9 (J)	1 (U)	1 (U)	50	1 (U)	74	1 (U)	1 (U)	1 (U)
4/25/02	2.9	1 (U)	4.5	1 (U)	110	1 (U)	26	1 (U)	24	1.8	1 (U)	1 (U)	41	1 (U)	76	1 (U)	1 (U)	1 (U)
10/21/02	2.6	1 (U)	1.06	1 (U)	155	1 (U)	27.5	1 (U)	11.3	1 (U)	1 (U)	1 (U)	33.6	1 (U)	46.8	1 (U)	1 (U)	1 (U)
4/17/03	2.8	1 (U)	2.5	0.23 (J)	73	1 (U)	19	0.93 (J)	23	4.4	1 (U)	3.5 (B)	31	0.38 (J)	38	0.31 (J)	0.81 (J)	1 (U)
12/1/03	2	1 (U)	2	1 (U)	104 (D)	1 (U)	21.4	1 (U)	9	1	1 (U)	1 (U)	22.6	1 (U)	31.4	1 (U)	1 (U)	1 (U)
6/9/04	1.34	1 (U)	1.49	1 (U)	91.9	1 (U)	22.4	1 (U)	6.98	1 (U)	1 (U)	1 (U)	21.5	1 (U)	28.3	1 (U)	1 (U)	1 (U)
10/20/04	2.07	1 (U)	2.47	1 (U)	100	1 (U)	24.6	1 (U)	5.59	0.83 (J)	1 (U)	1 (U)	25.7	0.72 (J)	29.4	2.74	1 (U)	1 (U)
6/21/05	1 (U)	1 (U)	1.58	1 (U)	110	1 (U)	30.4	0.48 (J)	3.93	2.04	0.74 (J)	1 (U)	29.1	1.66	34.9	1.28	1 (U)	1 (U)
11/18/05	11	1 (U)	5.2	0.67 (J)	150	1 (U)	31	0.42 (J)	20	6.3	1 (U)	1 (U)	81	4.5	90	1.6	1 (U)	1 (U)
4/25/06	35	0.16 (U)	18	4.8	81	0.19 (U)	56	0.16 (U)	920	390	20	1.7	150	5.7	150	7.6	0.68 (U)	5.6
6/5/06	27.4	1 (U)	1 (U)	1 (U)	60.1	1 (U)	45	1 (U)	2040 (D)	793 (D)	27.2	1 (U)	125 (D)	3	158 (D)	4.6	6	8.6
10/5/06	53.3	1 (U)	73.1	1 (U)	60.1	1 (U)	45.1	1 (U)	6580 (D)	0.78 (J)	6.9	7.3	87.2	1 (U)	93.7	1 (U)	26.1	1 (U)
6/26/07	11	0.43 (U)	5.2	1.4 (J)	3.4	0.51 (U)	4.1	0.43 (U)	320	590	0.32 (U)	2.6 (J)	6.8	0.53 (U)	5.3	0.43 (U)	12	48
7/24/07	290	0.32 (U)	95	0.52 (J)	48 (J)	0.38 (U)	77	0.32 (U)	6500	330	21 (U)	6.7	94	0.4 (U)	88	0.32 (U)	350	18
8/6/07	370	0.16 (U)	99	0.35 (J)	58	0.19 (U)	99	0.16 (U)	7700	130	8.5 (U)	3.3	89	0.2 (U)	88	0.16 (U)	420	8.6
8/16/07	180	0.32 (U)	47	0.4 (J)	24	0.38 (U)	67	0.32 (U)	4500	190	4.1 (JB)	5.4 (B)	28	0.4 (U)	42	0.32 (U)	420	34
10/9/07	300	0.16 (U)	93	0.44 (J)	42	0.19 (U)	88	0.16 (U)	5800	300	13 (U)	4.8	70	0.2 (U)	93	0.16 (U)	470	36
11/8/07	270	0.16 (U)	94	0.5 (J)	40	0.19 (U)	85	0.16 (U)	5400	140	13 (U)	4.7	78	0.2 (U)	110	0.16 (U)	590	36

Notes: 1,1,1-TCA = 1,1,1-trichloroethane; 1,1-DCE = 1,1-dichloroethene; CT = carbon tetrachloride; CF = chloroform; cis-1,2-DCE = cis-1,2-dichloroethene; MCI = methylene chloride; PCE = tetrachloroethene; TCE = trichloroethene; VC = vinyl chloride. R1-0 = influent, R2-E = effluent; formal sampling location names are Mound R1-0 and Mound R2-E. Shaded, bold value indicates detected concentration exceeds corresponding level stipulated in RFLMA Attachment 2, Table 1 (DOE 2007d). Lab qualifiers: J = result is estimated below the sample quantitation limit; U = analyte not detected at the indicated concentration; B = chemical was also detected in the blank; D = analysis was performed at a dilution.



Notes: Constituents and their respective RFLMA Table 1 standards (µg/L; DOE 2007d): CT = carbon tetrachloride, 5; PCE, 5; TCE, 5; 1,1,1-TCA, 200; 1,1-DCE, 7; cis-1,2-DCE, 70; VC = vinyl chloride, 0.2. in = influent (Mound R1-0), ef = effluent (Mound R2-E). Lab qualifiers not indicated except for U (analyte not detected at the indicated concentration); other qualified data plotted at reported value for simplicity. Note logarithmic concentration scale.

Figure 3-206. Recent Concentrations of Select VOCs in MSPTS Influent and Effluent

Four grab samples for the analysis of VOCs were collected in 2007 at the performance monitoring location for the MSPTS, surface-water station GS10. Two of these samples, one each collected in June and November, represent RFLMA-required monitoring; the other two, both collected in August, represent additional, non-RFLMA performance checks. As in prior years, results include detections of VOCs; none exceeded the corresponding surface-water action levels. VOCs detected in 2007 are summarized in Table 3-89.

Table 3-89. Summary of VOCs Detected in 2007 at GS10

Date	Constituent	Result (µg/L)	Qualifier
6/5/2007	TCE	0.18	J
6/5/2007	cis-1,2-DCE	66	
8/6/2007	cis-1,2-DCE	1.7	
11/8/2007	1,2-DCA	0.15	J
11/8/2007	cis-1,2-DCE	4.7	

East Trenches Plume and Treatment System

The East Trenches Plume is an area of contamination named after several buried disposal trenches that contribute VOCs to groundwater. These trenches are located on the pediment south of South Walnut Creek, in former OU 2. The source of this plume is predominantly Trenches T-3 and T-4, which were remediated in 1996. In addition, a portion of the 903 Pad Plume flows toward the northeast and joins the East Trenches Plume. A treatment system (the ETPTS) was installed in 1999 to intercept and treat contaminated groundwater flowing toward the B-Series Ponds and South Walnut Creek.

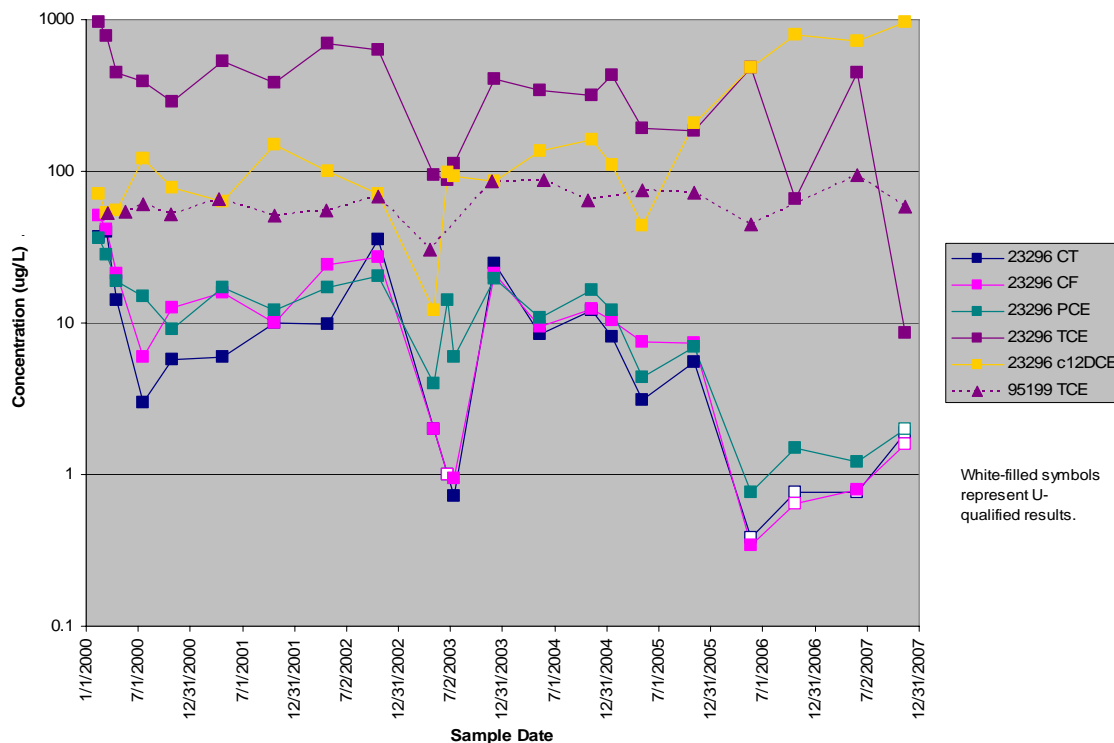
East Trenches Plume

Evaluation wells 3687 and 05691 monitor the source areas of the East Trenches Plume, Trenches T-3 and T-4, respectively. More distal portions of the plume are monitored by Evaluation well 03991 and Sentinel well 04091 to the east-northeast, and AOC well 00997 at the mouth of Pond B-5 in the South Walnut Creek drainage. Sentinel wells 95099, 95199, 95299, 23296, and TH046991 monitor the ETPTS and downgradient portions of the plume.

None of the Evaluation wells was sampled in 2007. The AOC and Sentinel wells were all sampled in 2007.

AOC well 00997 was sampled twice in 2007 (May and November). No constituents exceeded the RFLMA Table 1 standards. Nitrate was detected in the May sample (at 4.8 mg/L), and one VOC was detected in the November sample (1,3-dichlorobenzene (DCB), at 0.36 µg/L, J-qualified). Nitrate is typically detected in samples from this well, although at concentrations less than 1 mg/L. AOC well 00997 will continue to be monitored in accordance with RFLMA.

All Sentinel wells supporting the East Trenches Plume/ETPTS were sampled twice in 2007. Analytical data for these wells in 2007 were generally consistent with those from recent years. (Well TH046992 is represented by fewer data, as it was added to the network in 2005.) RFLMA Table 1 standards were exceeded in samples from wells 23296 and 95199, which is consistent with past conditions, as is the fact that samples from well 23296 contained the highest concentrations of VOCs of this group of wells. Figure 3-207 displays VOCs most commonly detected in these two wells at concentrations exceeding the corresponding RFLMA action level. Refer to Appendix B.3 for S-K trend plots.



Notes: Constituents and their respective RFLMA Table 1 standards (µg/L; DOE 2007d): CT = carbon tetrachloride, 5; CF = chloroform, 3.4; PCE, 5; TCE, 5; c12DCE = cis-1,2-DCE, 70. In addition to nondetects (U-qualified results), several other results were qualified (D, J), but are not shown differently for the sake of simplicity. Note logarithmic concentration scale.

Figure 3-207. Most Commonly Detected VOCs in Sentinel Wells Downgradient of the ETPTS

S-K trend plots (Appendix B.3, and summarized above in Table 3-86) indicate 95 percent significant trends for several constituents monitored in East Trenches Plume wells. Well 23296 is represented by significant trends for carbon tetrachloride (decreasing), chloroform (decreasing), cis-1,2-DCE (increasing), and PCE (decreasing). These trends suggest the source removal actions are affecting concentrations of VOCs as desired; the increasing trend in cis-1,2-DCE suggests ongoing degradation of parent compounds.

Well TH046992 is also represented by a significant trend, in this case for cis-1,2-DCE (increasing), although the data set includes many nondetects and therefore the trend may not be valid. Distal well 04091 is represented by a significant trend for carbon tetrachloride (decreasing); this data set also contains many nondetects.

Wells monitoring the East Trenches Plume will continue to be monitored in accordance with RFLMA. As additional data are collected, additional significant trends should become evident.

East Trenches Plume Treatment System

The ETPTS was installed in 1999. Its design is very similar to that of the MSPTS. However, the intercept trench for the ETPTS is 1,200 feet long, compared to the 220-foot-long MSPTS trench.

The longer trench is required to intercept the broader East Trenches Plume as it flows toward South Walnut Creek and the B-Series Ponds.

The ETPTS treated approximately 951,000 gallons of water in 2007, a nearly 50 percent increase over the volume treated in 2006. This increase is most likely due to the increased precipitation in 2007 relative to 2006, particularly in the early winter months. This volume also continues the pattern observed since closure, when the flow to the system was reduced by a factor of two to three. See Table 3-90 for annual estimates of the volume of water treated by the ETPTS, and Figure 3-208 for a hydrograph showing flow estimates since January 2000. Figure 3-209 provides a hydrograph for CY 2007.

Table 3-90. Estimated Volumes of Water Treated by the ETPTS

Calendar Year	Annual Estimates of Volume Treated (gallons)	Estimated Cumulative Volume Treated (gallons)
2000	1,633,000	2,800,000
2001	1,900,000	4,700,000
2002	≤1,000,000	5,700,000
2003	2,100,000	7,800,000
2004	1,500,000	9,300,000
2005	1,800,000	11,100,000
2006	675,000	11,775,000
2007	951,000	12,726,000

Note: Estimates for years 2000 through 2004 are compiled from K-H (2000a, 2000b, 2000c, 2000d, 2001a, 2003, 2005a, 2005f).

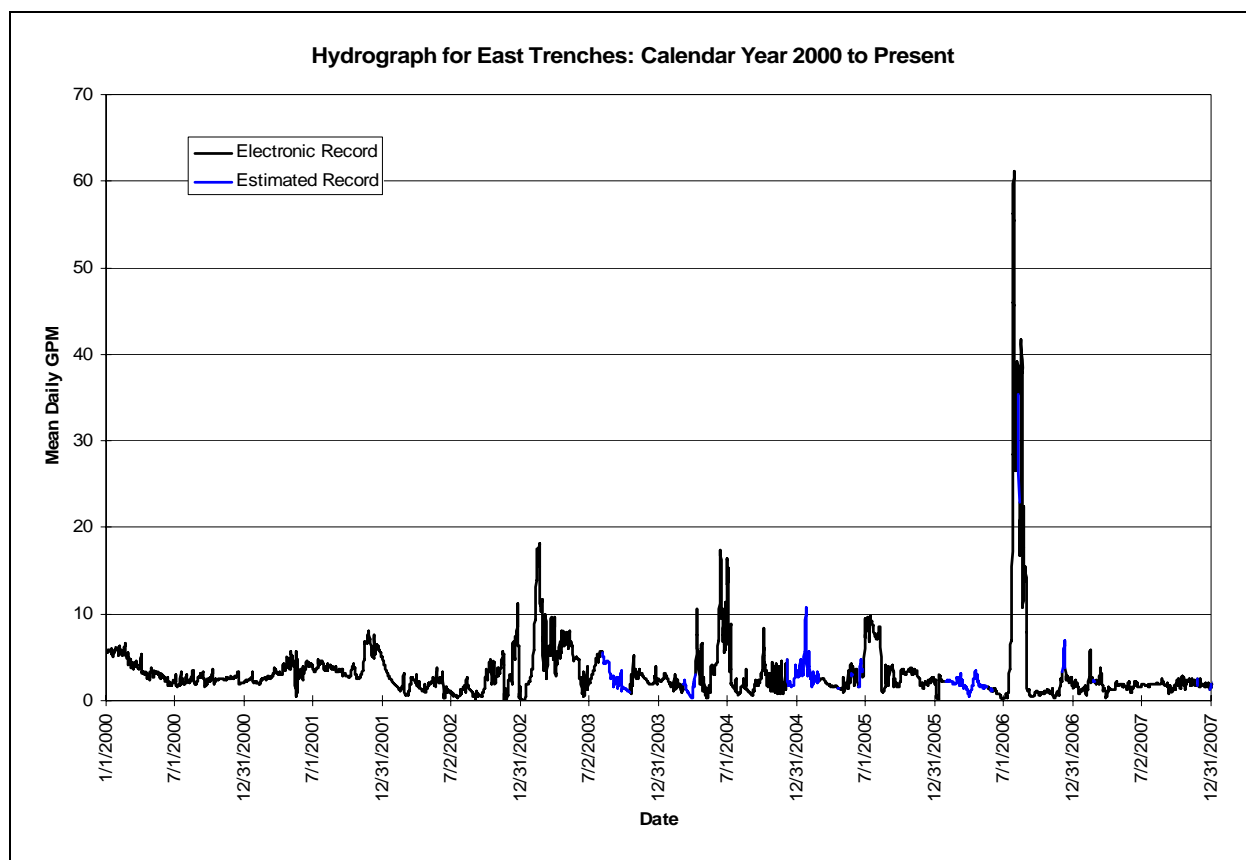


Figure 3-208. Hydrograph for ETPTS Since 2000

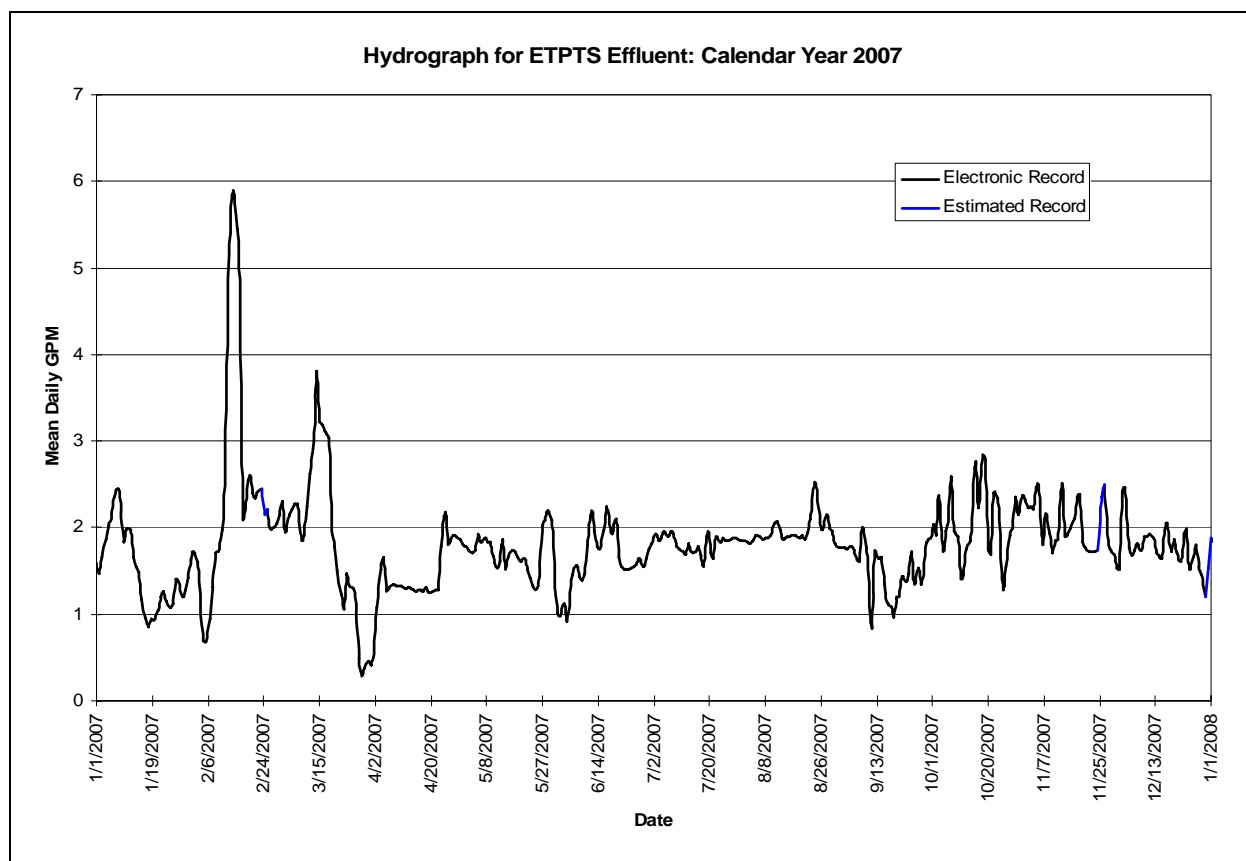


Figure 3-209. Hydrograph for ETPTS for CY 2007

Routine maintenance activities at the ETPTS were conducted throughout 2007, and are reported in Section 2.6.2. As described in the 2006 annual report (DOE 2007e), the ETPTS and MSPTS treatment cell plumbing was upgraded that year to provide an upflow condition within each cell. As at the MSPTS, the ETPTS was changed to upflow configuration in September 2007 to assess whether treatment effectiveness varied significantly under different flow conditions. Samples were collected on two occasions: approximately 1 and 2 months after the change in flow direction. Results indicated no obvious, meaningful differences in flow regimes, and the system was returned to downflow in January 2008 to reduce maintenance needs.

The ETPTS was sampled four times: once each in June, August, October, and November. The June and November samples were collected in accordance with RFLMA, while the August and October samples were collected for performance checks and to support the upflow versus downflow assessment described above.

Treatment of groundwater by the ETPTS in 2007 was generally consistent with previous years in which it operated effectively (i.e., those years in which the media did not need to be replaced). Effluent water quality reflected a dramatic reduction in VOC load, but as in other years there were some VOCs detected in the effluent. A summary of the VOCs most commonly detected since 2003 (for brevity) is presented in Table 3-91; refer to quarterly reports (DOE 2007g, 2007h, 2008a) and Appendix B.6 for additional data from 2007.

Table 3-91. Summary of Recent VOC Data from ETPTS Influent and Effluent

Date	CT		CF		MCI		PCE		TCE	
	ET In	ET Ef	ET In	ET Ef	ET In	ET Ef	ET In	ET Ef	ET In	ET Ef
1/28/2004	130	1 (U)	71	1.1	5 (U)	20	290	0.93 (J)	2300	1.8
2/25/2004	150	1 (U)	71	1.4	2.7 (JB)	19 (B)	270	1.1	2400	2.5
3/22/2004	180	1 (U)	71	1	2.6 (JB)	21	270	1.2	2400	1.8
5/26/2004	216	1 (U)	65.1	1 (U)	1 (U)	17	618 (D)	3.38	5510 (D)	6.36
6/22/2004	130	1 (U)	59	1 (U)	6.7 (JB)	14 (B)	240	1.9	1900	1.8
7/29/2004	142 (D)	1 (U)	54.1	1 (U)	2.3	14.1 (B)	354 (D)	1.8	1960 (D)	0.69 (J)
8/19/2004	68.1	1 (U)	26.6	1 (U)	1 (U)	13.7	137 (D)	1.2	774 (D)	0.55 (J)
10/20/2004	160	1 (U)	72.9	2.56	1 (U)	15.6	230 (D)	2.13	1170 (D)	1.91
5/12/2005	131	1 (U)	66	22.2	1 (U)	14.6	256 (D)	21.9	2280 (D)	33.1
6/7/2005	160	1 (U)	81	30	10 (U)	22 (B)	340	36	3300	66
11/2/2005	151	1 (U)	74.8	0.73 (J)	250 (U)	18.2	350	1 (U)	2500	4.4
5/17/2006	170	0.23 (J)	75 (J)	1.9	0.32 (U)	32	280	4.1	2800	2.8
10/31/2006	120	0.19 (U)	75	0.16 (U)	6.4 (U)	0.32 (U)	290	0.85 (J)	2100	0.18 (J)
6/26/2007	110	0.19 (U)	70	0.16 (U)	1.6 (U)	0.32 (U)	320	9.7	2500	4.8
8/16/2007	150	0.19 (U)	81	0.16 (U)	8 (JB)	0.73 (JB)	390	4.4	2500	1.1
10/9/2007	130	0.19 (U)	71	0.25 (J)	3.2 (U)	1.7	270	9.5	2200	5.3
11/8/2007	110	0.19 (U)	64	0.16 (U)	3.2 (U)	0.32 (U)	260	9.1	2200	4.4

Notes: Constituents and their respective RFLMA Table 1 standards (µg/L; DOE 2007d): CT = carbon tetrachloride, 5; CF = chloroform, 3.4; MCI = methylene chloride, 4.6; PCE, 5; TCE, 5. ET In = influent (ET INFLUENT), ET Ef = effluent (ET EFFLUENT). Shaded, bold value indicates detected concentration exceeds corresponding RFLMA standard. Lab qualifiers: J = result is estimated below the sample quantitation limit; U = analyte not detected at the indicated concentration; B = chemical was also detected in the blank; D = analysis was performed at a dilution.

In addition to the constituents summarized in Table 3-91, several other VOCs were detected in system effluent in 2007 (see DOE 2007g, 2007h, 2008a and Appendix B.6 for the data). Of those, VC was the only compound reported at a level exceeding the RFLMA Table 1 concentration (represented by the PQL, 0.2 µg/L). This constituent was repeatedly reported at concentrations exceeding 0.2 µg/L in 2000, but then not again until 2004 (once), 2005 (once), 2006 (once), and in all four samples collected in 2007. Many of these detections are J-qualified, indicating the constituent was positively identified but the result is estimated. Detections in 2007 ranged from 0.43 µg/L (J-qualified) to 1.7 µg/L. Note that the previous action level for VC set by RFCA Attachment 5 (CDPHE, DOE, and EPA 2003), which was in effect until RFLMA was signed in March 2007, was 2 µg/L. Because it has not been detected at a concentration exceeding this since monitoring of the ETPTS effluent began, VC has not previously been reported as exceeding the standard.

The performance monitoring location for the ETPTS is POM2, which is located in Pond B-4. Sampling in support of the ETPTS began at this location in 2005. Grab samples were collected from POM2 in June and November 2006. No VOCs were detected in either sample. No samples were collected in 2007.

Solar Ponds Plume and Treatment System

The SPP is an area of elevated nitrate and U concentrations in groundwater. (Note: The analytical data report concentrations of nitrate/nitrite as N; this is referred to herein simply as nitrate.) The former SEPs, which were located on the pediment in the northeastern portion of the

former IA, were the source of this contamination. Liquid wastes generated during the production era were stored in these ponds. Leaks that occurred over the years are the source of the groundwater plume. The following paragraphs describe the plume, the treatment system installed to address this contamination, and work performed in 2007 on the system. Discussion of special investigations of the system is provided in Section 3.1.5.4.

Solar Ponds Plume

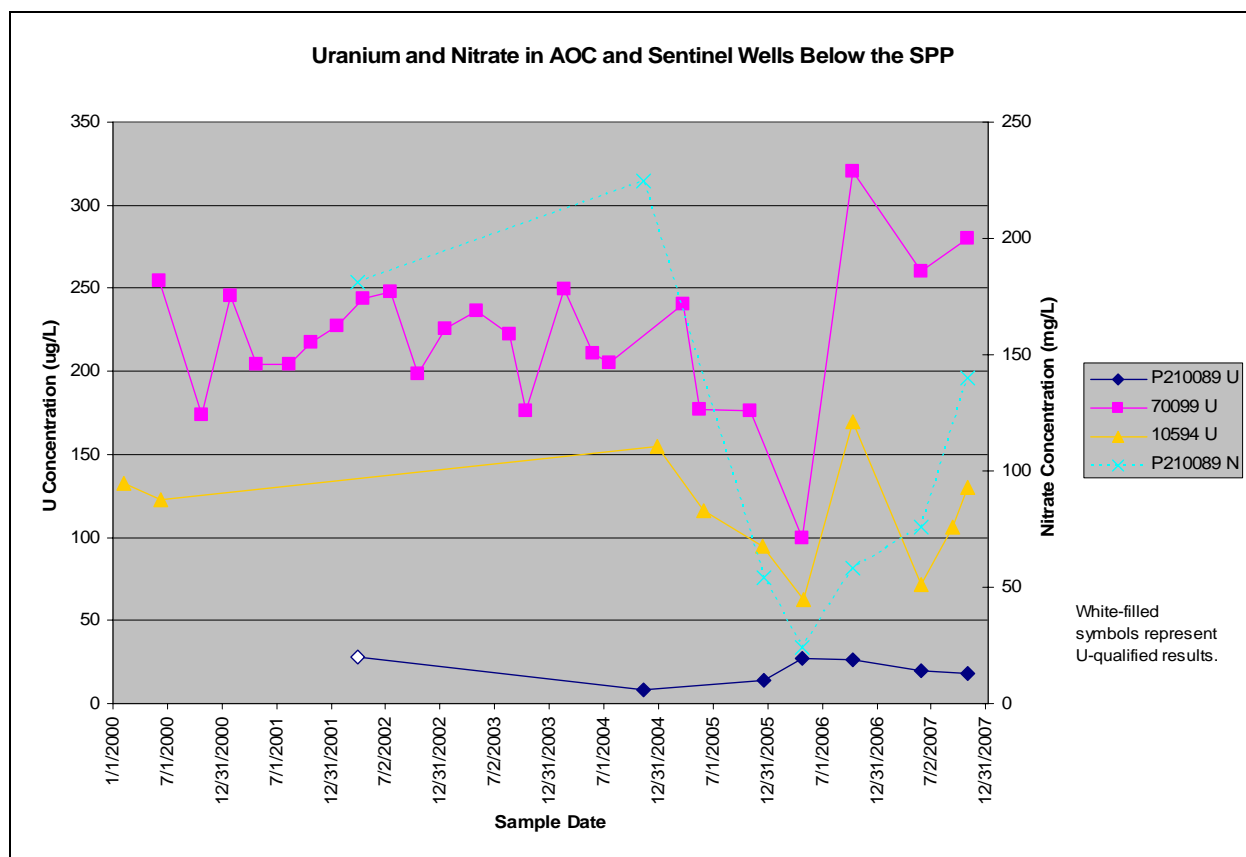
Groundwater in the SEP area is contaminated with nitrate and U. The westernmost portion of this area, generally coinciding with the location of former Pond 207-C, is also contaminated with VOCs.

The source area of the SPP (the SEPs) is monitored by a line of eight Evaluation wells installed immediately downgradient of the SEPs (generally along the north, east, and south sides of the former SEPs), with additional wells located at greater distances from the source. Another Evaluation well is positioned at the south edge of former Pond 207-C, in or near the VOC source area. This distribution effectively monitors groundwater flowing north/northeastward, the primary contaminant flowpath, as well as eastward and southeastward, which are less significant flowpaths.

None of these Evaluation wells was sampled in 2007; they are next scheduled for sampling in 2008. However, Sentinel wells P210089 and 70099 and AOC well 10594 were sampled. Each of these wells was sampled twice in 2007 in accordance with RFLMA.

Figure 3-210 presents a summary of nitrate and U concentrations from these three wells. Nitrate data for wells 70099 and 10594 are not included, because all data from the former are under 2 mg/L, and from the latter are under 1 mg/L. U data represent results reported in $\mu\text{g/L}$ as well as isotopic data reported in pCi/L (which were then converted to mass and summed for total U concentrations in mass units). As stated in Section 3.1.2.3, the U result in November 2007 from AOC well 10594 is above the 120- $\mu\text{g/L}$ threshold; if the next sample collected is also above that threshold, a reportable condition will apply. U in this well has been repeatedly characterized as 100 percent natural, most recently in September 2007.

As indicated on Figure 3-210, of the SPP wells sampled in 2007, that nearest the source (Sentinel well P210089) does not produce groundwater samples with the highest concentrations of U; rather, this is the case with samples from well 70099, located at the northwestern end of the SPPTS groundwater intercept trench. Of these wells, even most-distal well 10594 produces samples with higher concentrations of U than does well P210089. In contrast, concentrations of nitrate are highest in well P210089, and are uniformly less than 2 mg/L in wells 70099 and 10594. This further substantiates the previous findings that U in groundwater samples from wells 70099 and 10594 is natural, and is not part of a plume of anthropogenic U and nitrate. (Samples from well 70099 were characterized in 2002 as being 99.4 percent natural.)



Note: U = uranium (total), N = nitrate + nitrite as N.

Figure 3-210. Nitrate and U Concentrations in AOC and Sentinel Wells Monitoring the SPP

Concentrations of nitrate in samples collected in 2007 from these wells are generally consistent with previous results, although the data from well P210089 are too few to make any firm conclusions. Concentrations of U are also generally consistent with past years, although data from samples collected in late 2006 through 2007 from well 70099 continue to be somewhat higher in U concentration than was the case in past years. As noted in the 2006 Annual Report (DOE 2007e), both samples collected in that year were anomalous, with the first (collected in April) representing the lowest concentration in the period of record, and the second (collected in October) the highest. The 2007 data suggest the latter, elevated 2006 result is more reasonable of the two. Additional data will be collected per RFLMA, and will assist in determining whether U concentrations are truly increasing in this location. Note that calculations of S-K trends did not identify U in well 70099 as having an increasing (or decreasing) trend at even the 80 percent level of significance; conversely, concentrations of nitrate in samples from this well appear to be decreasing at the 95 percent level of significance.

The VOC plume in the western SEP area was not monitored in 2007. Samples for the analysis of VOCs were collected from Sentinel well P210089, located a short distance downgradient of source-area well P210189; no VOCs were detected in either sample.

Solar Ponds Plume Treatment System

Like the ETPTS, the SPPTS was installed in 1999. In basic terms, the system is very similar to the MSPTS and ETPTS, with an intercept trench (1,100 feet long) and two treatment cells. However, unlike the ETPTS and MSPTS, this system is designed to treat water with elevated concentrations of nitrate and U. As such, the treatment media in the SPPTS differs from that in the VOC-treating MSPTS and ETPTS. The treatment media in the SPPTS consists of organic material (sawdust) and ZVI.

Another difference between the SPPTS and the other two systems is that the water collected in the intercept trench is actively pumped into the treatment cells, rather than flowing into the cells by gravity. This is accomplished using a solar-charged, battery-powered pump system. This component of the SPPTS, together with the collection well that houses the pump and is installed within the trench, was added in 2002.

Routine maintenance activities at the SPPTS were conducted throughout 2007, and are reported in Section 2.6.3. The telemetry was also upgraded in 2007, allowing remote collection of system data including water level in the collection well ("SPIN") and flow. A temporary flume was installed at the DG to monitor surface-water flow from the area in which the DG is located. This is discussed in greater detail below.

As discussed in Section 3.1.5.4, treatability studies and other investigations were performed in 2007 at the SPPTS.

The SPPTS removed nitrate and U effectively throughout 2007. Repairs made in September 2006 were determined to have corrected the problem previously observed and reported with respect to inadequate nitrate treatment (DOE 2007e).

The SPPTS treated approximately 244,000 gallons in 2007. This is generally consistent with volumes treated since the system was modified with the addition of the pump. Table 3-92 lists the annual estimates of the volume of water treated by the SPPTS, and Figure 3-211 presents a hydrograph showing flow since January 2000. Figure 3-212 provides a hydrograph for CY 2007.

Table 3-92. Estimated Volumes of Water Treated by the SPPTS

Calendar Year	Annual Estimates of Volume Treated (gallons)	Estimated Cumulative Volume Treated (gallons)
2000*	64,000	64,000
2001*	424,000	452,700
2002	5,600**	458,000
2003	340,000	797,000
2004	230,000	1,027,000
2005	140,000	1,167,000
2006	251,000	1,418,000
2007	244,000	1,662,000

Notes: Estimates for years 2000 through 2004 are compiled from KH (2000a, 2000b, 2000c, 2000d, 2001a, 2003, 2005f, 2005a).

* = Annual and cumulative volume estimates for 2000 and 2001 are suspect, as a sum of the volumes presented in each of the quarterly reports for 2000 and statements regarding the volume for 2001 disagree by approximately 35,000 gallons.

** = Most of this volume was from the former Modular Storage Tanks (K-H 2003).

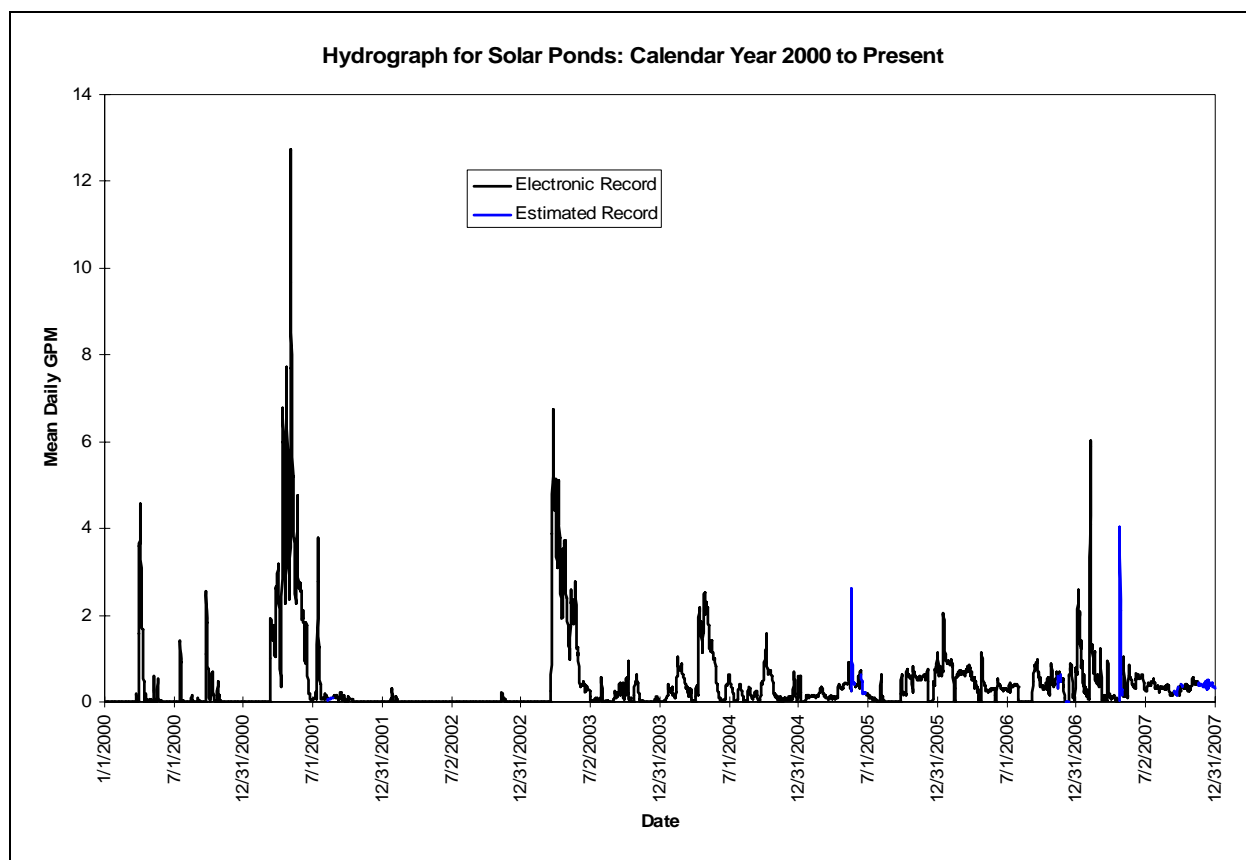


Figure 3-211. Hydrograph for SPPTS Since 2000

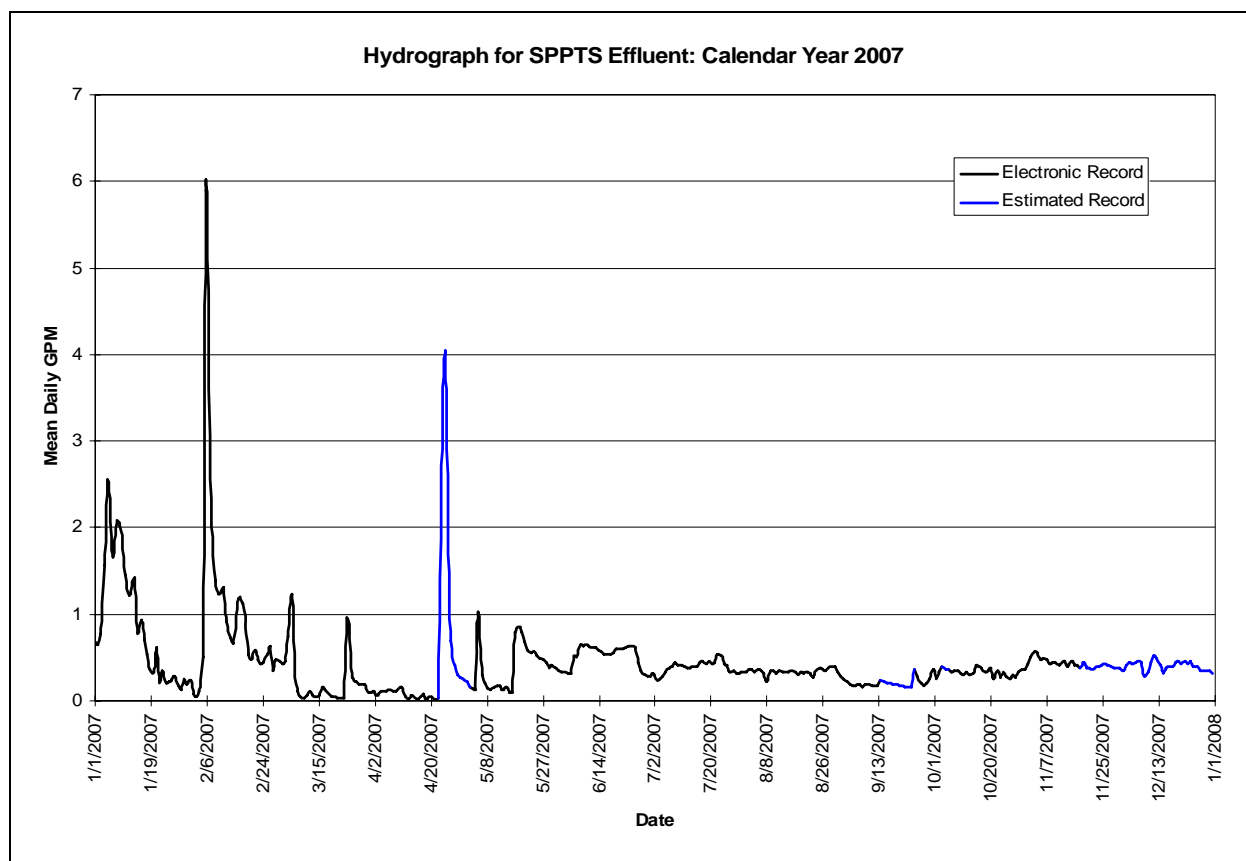
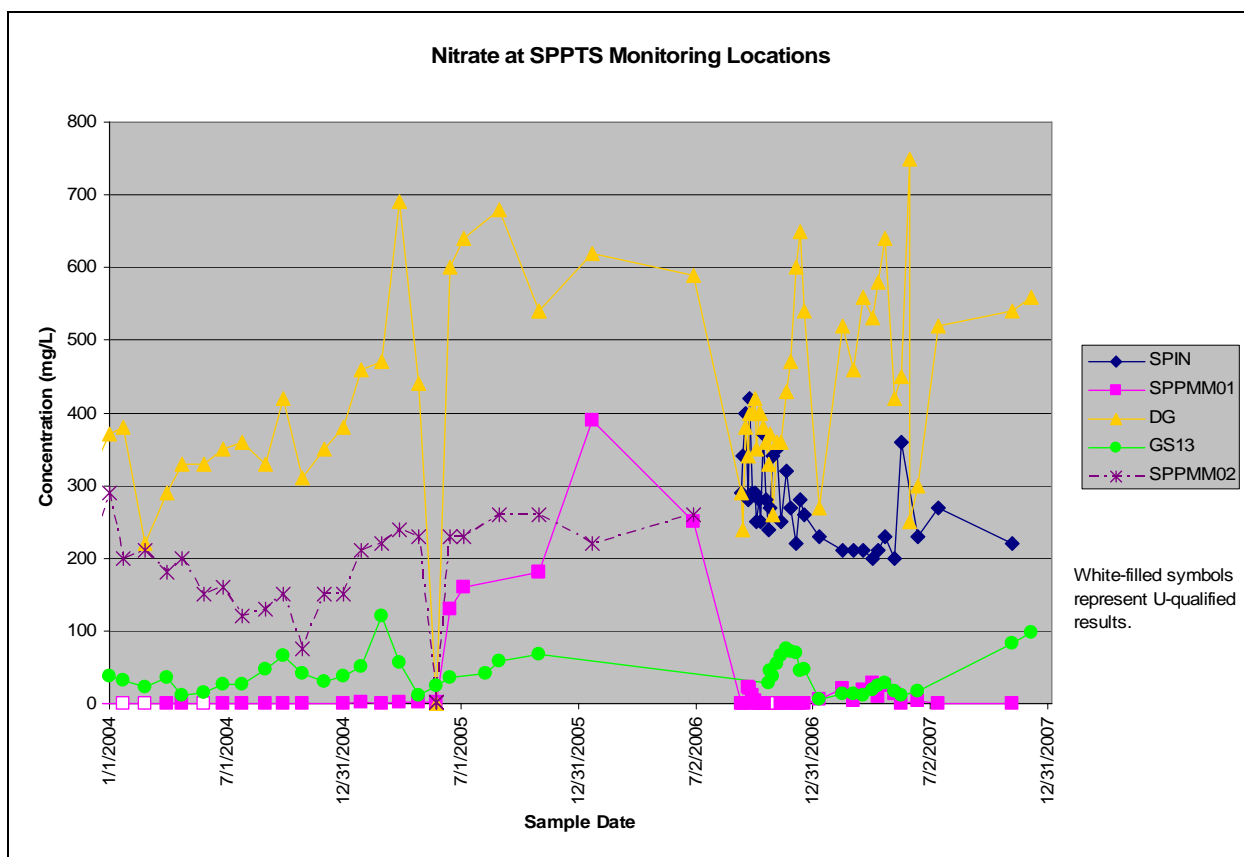


Figure 3-212. Hydrograph for SPPTS for Calendar Year 2007

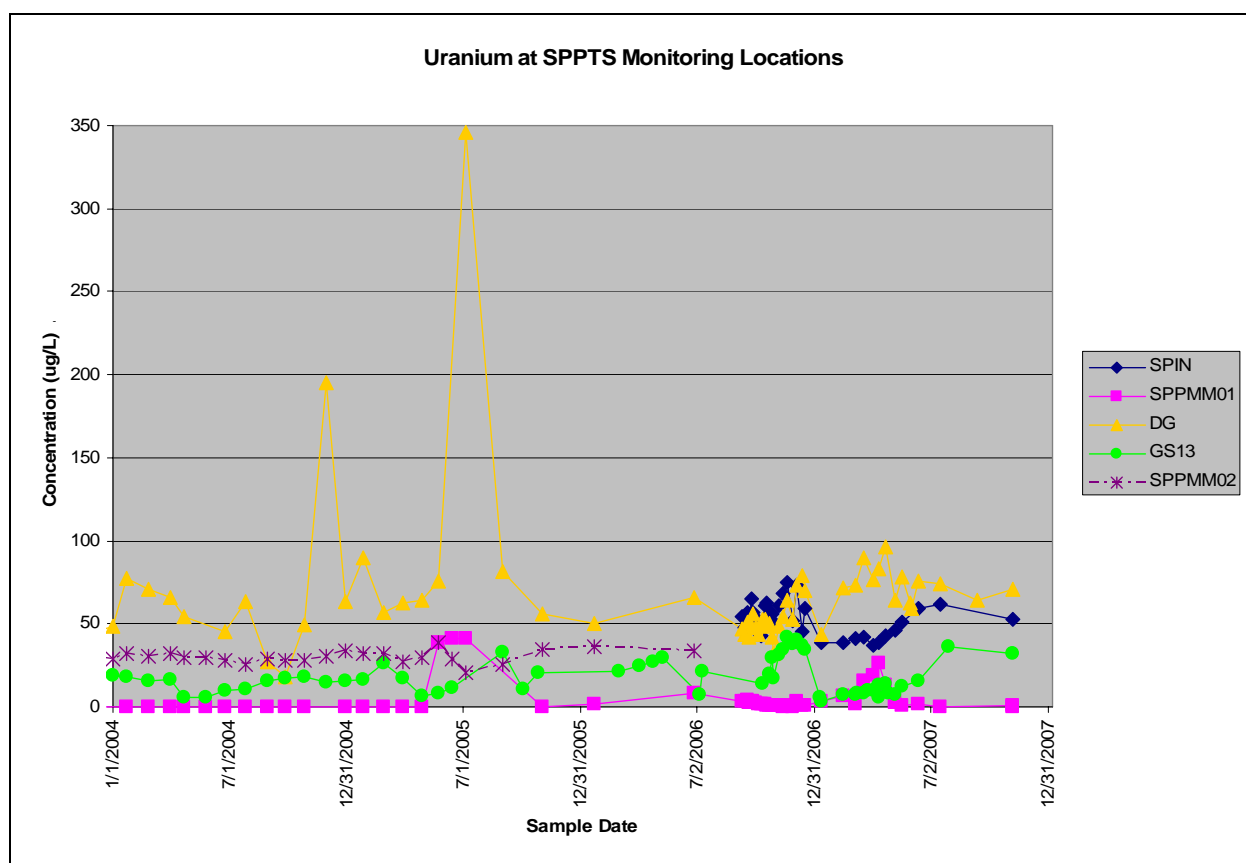
In accordance with and upon the signing of RFLMA in March 2007, the influent monitoring point for the SPPTS was changed from sample location SPPMM02 (a.k.a. piezometer 71099) to the collection well, referred to as SPIN. This change was made because samples collected from SPIN represent true influent water, while those collected from the nearby trench piezometer only approximate influent (see the 2006 Annual Report for additional discussion).

In much of early 2007, snowmelt increased flow through the system, with mean daily flow rates as high as 6 gallons per minute (gpm) (Figure 3-212). During this period, nitrate and U concentrations in system effluent (SPPMM01) were observed to increase, although most of the load continued to be removed by the system. Figure 3-213 provides an illustration of nitrate concentrations since 2004; Figure 3-214 shows a similar graph for U concentrations. In both figures, the effects of valve changes made in mid-2005 are obvious on concentrations of these constituents in the effluent, and to some degree at the DG and GS13 as well (see the 2006 Annual Report for additional discussion). The effects of the system repairs made in 2006 are also obvious on the nitrate graph (Figure 3-213). The effluent (i.e., collected at location SPPMM01) data for 2007 in both graphs show the slight increase in concentrations observed during the period of higher flow rates in early 2007, which corresponded to a decrease in residence time of water within the treatment cells.



Notes: SPIN = system influent (collection well); SPPMM01 = system effluent; DG = SPP Discharge Gallery; GS13 = surface water performance monitoring location; SPPMM02 = historic "influent" monitoring location. Analytical data from SPPMM02 are included for comparison only; this location is no longer monitored. See the 2006 Annual Report (DOE 2007e) for a more detailed discussion of this location, as well as a discussion of the activities responsible for the abrupt concentration changes seen in data for May 24, 2005. Some data are qualified with B (reported concentration is less than the required detection limit but above the instrument detection limit), but are not displayed differently for simplicity.

Figure 3-213. Recent Concentrations of Nitrate in Samples from SPPTS Monitoring Locations



Notes: SPIN = system influent (collection well); SPPMM01 = system effluent; DG = SPP Discharge Gallery; GS13 = surface water performance monitoring location; SPPMM02 = historic "influent" monitoring location. Analytical data from SPPMM02 are included for comparison only; this location is no longer monitored. See 2006 Annual Report (DOE 2007e) for more detailed discussion of this location, as well as a discussion of the activities responsible for the abrupt concentration changes seen in data for or immediately following May 24, 2005. Some data are qualified with J (detected at less than the detection limit; result is estimated) or H (one set of isotopic results at GS13; indicates analysis was done outside method maximum holding time) but are not displayed differently for simplicity. In addition, some of the data for individual isotopes, which are used to calculate total U concentrations, are U-qualified, but are not shown as nondetects for simplicity.

Figure 3-214. Recent Concentrations of U in Samples from SPPTS Monitoring Locations

Water quality in 2007 at the performance monitoring location for the SPPTS, GS13, is generally consistent with previous data. Concentrations of nitrate are below the 100-mg/L TM stipulated in RFLMA. However, a sample collected on December 6 reported a concentration of 98 mg/L, the second-highest concentration reported since 2000. (A concentration of 120 mg/L was reported on February 28, 2005.)

Although not required, S-K trend plots were constructed for locations at the SPPTS including SPIN, system effluent (SPPMM01), the DG, and GS13. These are provided in Appendix B.3. A high degree of scatter is evident in the data, which have been collected on varying schedules (from more than once weekly to twice in one year); these facts add uncertainty to any S-K trending (calculated using the RFLMA-assigned sampling frequency—used to define the seasons—of twice per year). The calculated trend of nitrate concentrations at surface-water location GS13 is increasing at the 95 percent confidence level (see S-K trend plot for GS13 in Appendix B.3). This is also the case with the nitrate trend at the DG. The trend for nitrate concentrations at SPIN is decreasing, also at the 95 percent confidence level, although the data record is significantly shorter at this location due to all the prior "influent" data being collected

from SPPMM02. (Indeed, a semiannual S-K trend calculation requires at least four *routinely* collected samples per season; therefore, a minimum of 4 full years of data should be collected before any trend calculated for SPIN data is given credence. This sampling frequency issue is the same as at the other SPPTS locations.) The nitrate trend at effluent location SPPMM01 indicates nitrate concentrations are also increasing, although very slightly; this is due to the plumbing problems in 2005–2006, as well as the minor increases discussed above related to higher flows in early 2007. Note that there are many nondetects for nitrate in this data set, but the total number of nondetects is less than 25 percent of the nitrate data for this location.

Other Plumes

In accordance with RFLMA, several other groundwater contaminant plumes were monitored during 2007. These include the 903 Pad/Ryan's Pit Plume, the collection of small plumes collectively referred to as the IA Plume (and often discussed, as in this report, in terms of the South and North IA Plume), the VC Plume (or OBP #1 Plume) located south of former B371, the OBP #2 Plume located immediately west of the Mound Plume, the IHSS 118.1 Plume (a.k.a. the carbon tetrachloride plume) located north-northwest of former B776, the PU&D Yard Plume, and the OU 1 Plume. Each of these is discussed below, followed by a short summary of data from other locations.

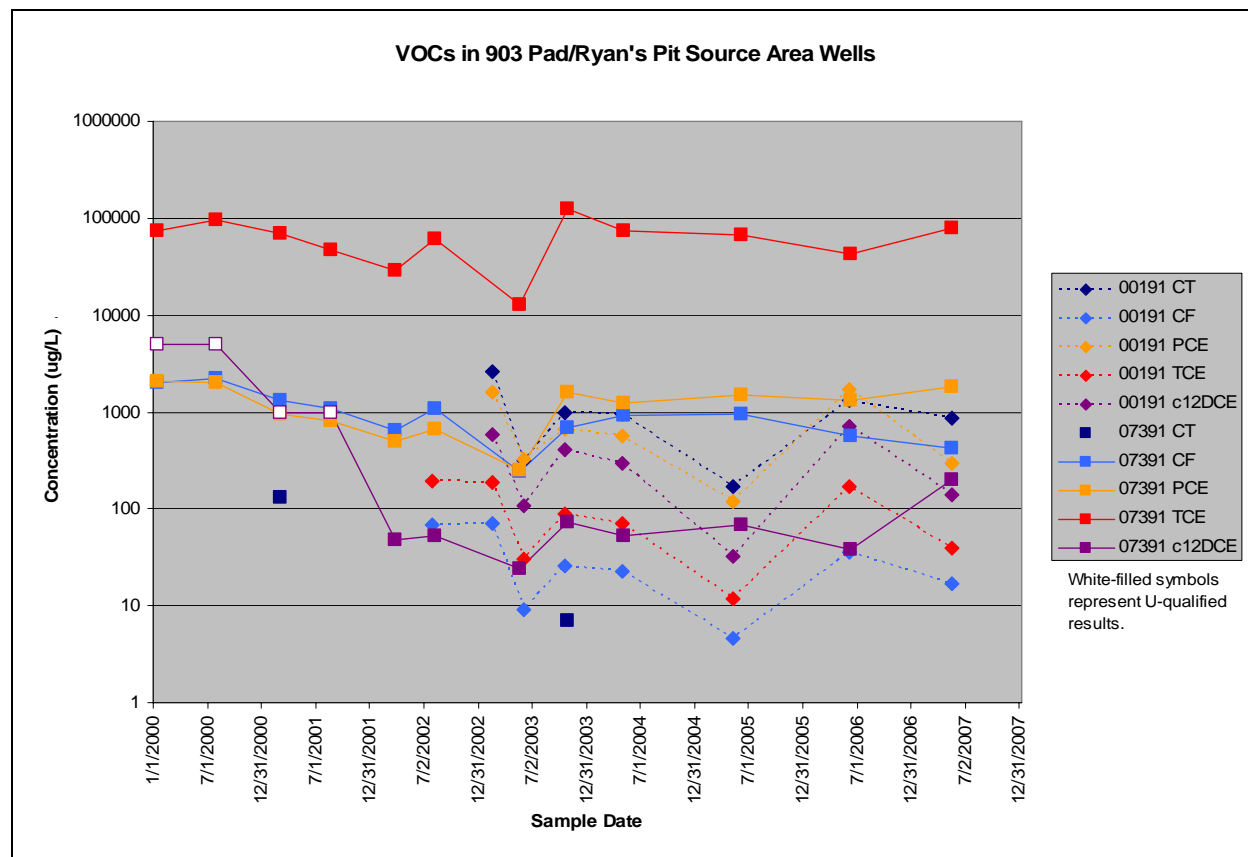
903 Pad/Ryan's Pit Plume

The 903 Pad/Ryan's Pit Plume was monitored in 2007 via several wells distributed within and at the margins of the plume. This plume bifurcates, with one portion flowing toward the southeast and Woman Creek, and the other flowing toward the northeast and joining the East Trenches Plume. The northeastern branch is not discussed here; refer to the text on the East Trenches Plume above.

Water quality within the southeastern portion of the 903 Pad/Ryan's Pit Plume appears generally consistent with that reported in previous years, but AOC well 10304, located on Woman Creek south of the SID and just east of Pond C-1, reported two first-time VOC detections. The sample collected in November 2007 reported J-qualified (estimated) detections of 1,3-DCB (0.43 µg/L) and TCE (0.17 µg/L), and a B-qualified (below the required detection limit but above the instrument detection limit) detection of nitrate at 0.034 mg/L. Each of these concentrations is well below the corresponding RFLMA Table 1 standard (94 µg/L, 5 µg/L, and 10 mg/L, respectively). Due to the very low concentrations detected and the tendency for the analytical data to include occasional anomalous results, particularly at such low concentrations, more data are required before it can be reasonably concluded that these detections are or are not related to groundwater from Ryan's Pit. This well will continue to be monitored and analytical data will be evaluated in accordance with RFLMA.

This plume is also monitored by downgradient Sentinel wells 90299 and 90399, source-area Evaluation wells 00191 (just east of the former 903 Pad) and 07391 (just south of the former Ryan's Pit), and in-plume Evaluation wells 90402, 50299, 00491, and 90804. The Evaluation wells that monitor the source-area (00191 and 07391) and the downgradient Sentinel wells (90299 and 90399) were all sampled in 2007. (The two Evaluation wells were sampled to better assess the continuing effects of HRC insertion at the 903 Pad and Ryan's Pit source areas just prior to closure.) These wells show contamination that is consistent with the source constituents.

Groundwater near the 903 Pad source area (represented by well 00191) is enriched in carbon tetrachloride relative to the PCE-TCE chain of compounds, although concentrations of PCE approach those of carbon tetrachloride. Conversely, groundwater near Ryan's Pit (represented by well 07391) contains much higher concentrations of TCE relative to carbon tetrachloride, which is frequently not detected (although the need to perform these analyses at a dilution has resulted in detection limits for carbon tetrachloride as high as 5,000 µg/L since 2000). Figure 3-215 shows time-series plots of carbon tetrachloride and its initial daughter product, chloroform, as well as PCE and its daughter products TCE and cis-1,2-DCE, for source-area wells 00191 and 07391. Note that some daughter products, particularly TCE, were heavily used during production at the Site and therefore do not always represent true "daughter" products.



Notes: CT = carbon tetrachloride, CF = chloroform, c12DCE = cis-1,2-DCE. Of the CT data from well 07391 since 1/1/2000, only two results are detections, the other 10 are nondetections. Both detections are shown. RFLMA surface-water action levels for these constituents (µg/L; DOE 2007d): CT, 5; CF, 3.4; PCE, 5; TCE, 5; cis-1,2-DCE, 70. Not shown are U-qualified data for CT from well 07391, as discussed. Several other results were qualified (D, E, J), but are not shown differently for the sake of simplicity. Note logarithmic concentration scale.

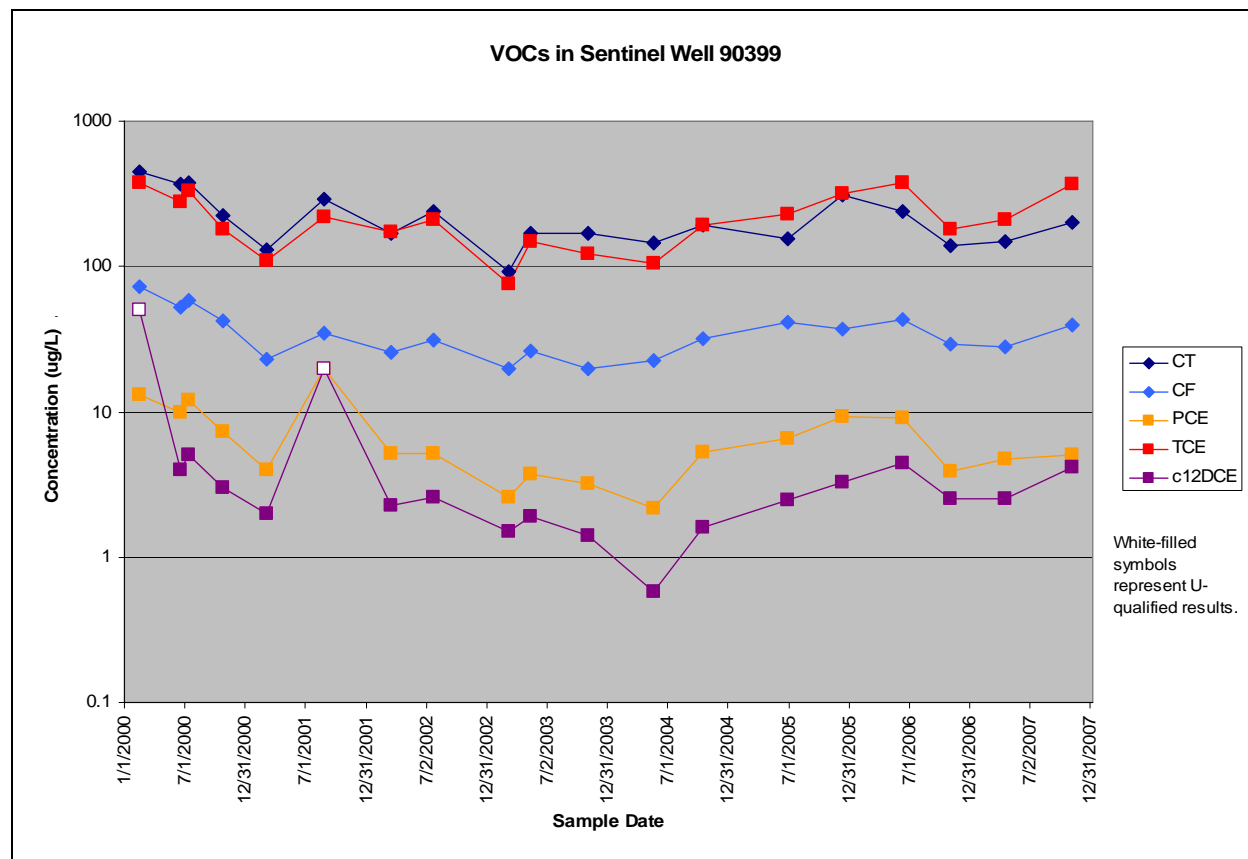
Figure 3-215. Concentrations of VOCs in Source-Area Wells 00191 (903 Pad) and 07391 (Ryan's Pit)

As is evident on Figure 3-215, the relative concentrations of different VOCs in each source-area well appear to track one another closely, although concentrations in one well do not closely track those in the other. The 2007 result for cis-1,2-DCE in samples from well 07391 show a relative increase, to the highest detected concentration in the data set. This may be indicative of enhanced biodegradation related to the HRC insertion, although the parent compounds do not appear to be reduced to any great extent, with only chloroform showing a slight decrease. A similar increase in cis-1,2-DCE is not evident in samples from well 00191, while a slight, relative increase in

carbon tetrachloride and its daughter, chloroform, appear to be indicated. Additional data will be required to determine the effects of HRC on contaminant concentrations in these two source areas.

Concentrations of VOCs in downgradient wells 90299 and 90399 in 2007 were generally consistent with previous data, and for several constituents show decreasing trends. As summarized in Table 3-86, decreasing trends in the concentrations of carbon tetrachloride, chloroform, and TCE are indicated in one or both wells; the decreasing trends in carbon tetrachloride and TCE concentrations in samples from well 90299 are significant at the 95 percent confidence level. Conversely, the trend for 1,1-DCE in well 90399 may be increasing, although the trend is not significant at the 95 percent confidence level. See Appendix B.3 for the corresponding S-K trend plots. VOC concentrations in samples from well 90399 continue to be higher than in adjacent well 90299, which is located just over 350 feet east of 90399.

The main VOCs present in samples from well 90399 are displayed on Figure 3-216. As shown, concentrations of carbon tetrachloride and TCE—the two dominant VOCs in the two source areas for the 903 Pad/Ryan's Pit Plume—are very similar, hence the conclusion that both source areas contribute to the contamination reported in samples from this well. While biodegradation of the PCE to TCE may also be contributing to the higher TCE concentrations, previous reports (K-H 2004a) suggest this mechanism would be of minor importance in this area.



Notes: RFLMA surface-water action levels for these constituents (ug/L; DOE 2007d): CT, 5; CF, 3.4; PCE, 5; TCE, 5; cis-1,2-DCE, 70. In addition to the nondetects (U-qualified results), several other results were qualified (D, J), but are not shown differently for the sake of simplicity. Note logarithmic concentration scale.

Figure 3-216. VOCs in Downgradient 903 Pad/Ryan's Pit Plume Well 90399

IA Plume

The IA Plume is actually a collection of several small VOC plumes grouped together for convenience and, in some cases, because of uncertainties regarding specific sources.

The South IA Plume is monitored by AOC well 11104. No VOCs were detected in samples collected in 2007 from this well. Concentrations of U, samples for which are collected because of the proximity of the OLF and former B444, continued to be well below the U threshold (DOE 2007d).

Upgradient of well 11104, wells monitoring the South IA Plume include Sentinel wells 11502 and 40305, and Evaluation wells 40005, 40205, P419689, and P416889. None of these Evaluation wells was sampled, but both Sentinel wells were sampled in 2007. Results are consistent with past samples.

As indicated in Table 3-86, the S-K trend plot for TCE in well 40305 is decreasing at the 95 percent confidence level. However, this trend is strongly affected by the presence of nondetects in the data, and therefore should not be taken at face value. In this case, of the 15 results for TCE reported since January 1, 2000, 11 are nondetects, and the highest detection reported is only 1 µg/L.

The North IA Plume is monitored by AOC well 42505. This well was sampled twice in 2007, and reported no confirmed detections of VOCs. This area is also monitored by Sentinel well 52505, which reported two J-qualified (estimated) detections of cis-1,2-DCE (highest detection estimated at 0.3 µg/L; RFLMA standard is 70 µg/L) and a J-qualified detection of VC (0.46 µg/L; RFLMA standard is represented by the PQL of 0.2 µg/L). Cis-1,2-DCE has been reported several times previously in samples from this well (or its predecessor, 1986), but this represents the first confirmed detection of VC reported for the well. However, detection limits have varied over the years. Note that this location is one of only two Site-wide that was found to provide at least adequate evidence of biodegradation (K-H 2004a), the other being Evaluation well 33502, which monitors the VC Plume source area.

VC Plume

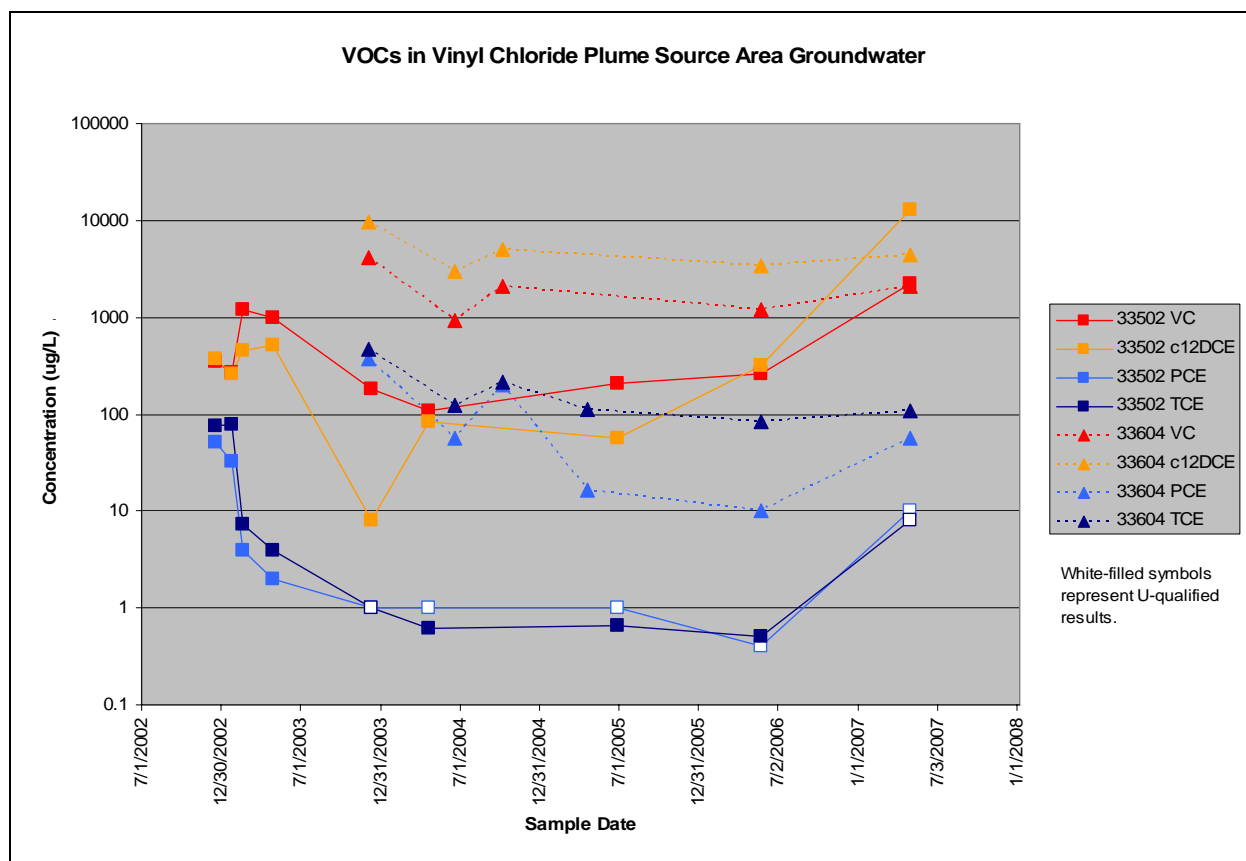
The VC Plume emanates from OBP#1 and/or the metal disposal/destruction sites (former IHSSs 134N and 134S). These IHSSs are on the margin of a valley that was buried during construction of B371 and became the site of the Portal 2 parking lots, among other facilities. The plume resides within and groundwater flow appears to be routed within that buried valley. This is the only Rocky Flats area where VC is present in such elevated concentrations.

The VC Plume is monitored by Sentinel well 33703 and Evaluation wells 33502 and 33604. Elevated concentrations of VC have been reported in wells 33502 and 33604 (as well as the latter's predecessor, 33603). Well 33703 was scheduled for routine RFLMA monitoring twice in 2007. In addition, both Evaluation wells were sampled to support a continuing assessment of the effects of the removal of impermeable surfaces that previously covered the plume source area, and of the regrading performed here (see Section 3.1.5.4 and Section 2.7.3).

Well 33502 is one location where strong evidence for biodegradation has been found (K-H 2004a), which may explain both the high concentrations of VC as well as the extremely limited aerial extent over which it has been observed. This biodegradation is probably a result of the slowly decomposing organic matter remaining from the vegetation that once grew within the valley. This would consume oxygen, providing an anaerobic environment suitable for reductive dechlorination of the chlorinated solvents most commonly found at RFS. Another breakdown product that is present at higher levels in samples from the source area is cis-1,2-DCE. Parent compounds including PCE and TCE are present in the groundwater in this area but at much lower concentrations compared with that of VC. While VC and cis-1,2-DCE are reported in groundwater samples from source-area wells 33502 and 33604 at concentrations in the hundreds to thousands, PCE and TCE are typically reported in the tens to hundreds (and are frequently not detected in well 33502).

Concentrations of cis-1,2-DCE have been quite variable in samples from well 33502. Prior to 2007, concentrations were reported to range from under 10 µg/L to over 500 µg/L. The sample collected in May 2007 reported a concentration of 13,000 µg/L cis-1,2-DCE. The VC concentration also increased significantly, although not to the same degree: this constituent had ranged from just over 100 µg/L to 1,200 µg/L, and in the May 2007 sample was reported at 2,200 µg/L. Nearby, concentrations of these constituents in groundwater samples from well 33604 have not reported the same degree of variability. These compounds are displayed via a time series plot on Figure 3-217. As is evident on that figure, the concentrations of VC and cis-1,2-DCE in groundwater samples collected from well 33502 increased in 2006 and 2007, and concentrations of all four constituents increased in samples from well 33604 collected in 2007. Downgradient Sentinel well 33704, however, produced samples in 2007 that were generally consistent with results from previous samples. PCE and TCE were not detected; cis-1,2-DCE and VC were both reported at J-qualified concentrations under 1 µg/L. (Data for this well are not displayed on Figure 3-217 because of all the nondetects and for clarity.) The associated results are published in DOE (2007h) and Appendix B.

Additional data will be required to determine whether the increasing concentrations noted above for source-area wells 33502 and 33604 represent the onset of trends. As noted in Section 3.1.5.4 and Section 2.7.3, the source area was the focus of regrading efforts intended to improve surface-water drainage off the source area.



Notes: VC = vinyl chloride; c12DCE = cis-1,2-DCE. RFLMA surface-water action levels for these constituents (ug/L; DOE 2007d): VC, 0.2; cis-1,2-DCE, 70; PCE, 5; TCE, 5. In addition to the nondetects (U-qualified results), several other results were qualified (J, D), but are not shown differently for the sake of simplicity. Note logarithmic concentration scale. Plots for well 33604 include data from its predecessor, 33603.

Figure 3-217. VOCs Present in the Vinyl Chloride Plume Source Area

OBP #2 Plume

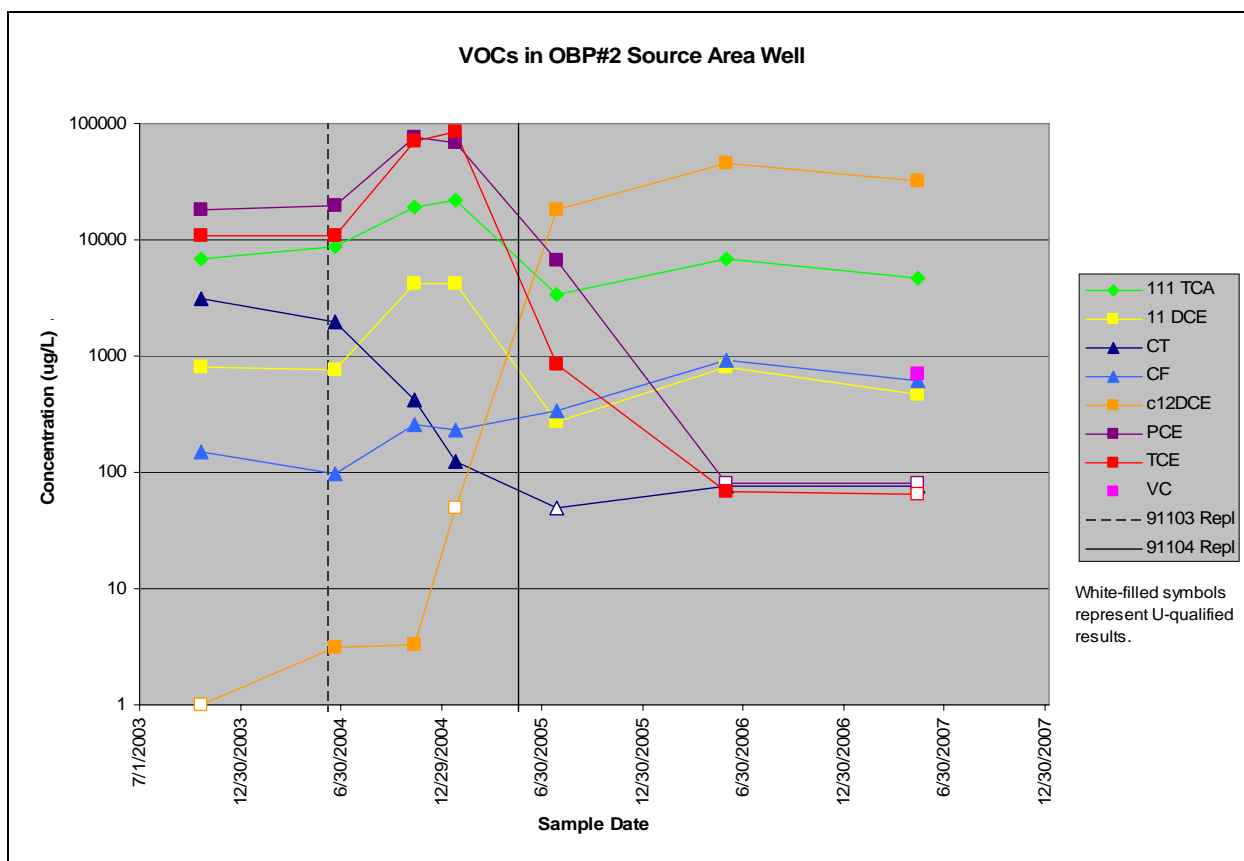
OBP #2 was located at the southeast corner of the former Protected Area (PA) fence just west of the Mound source area. Because of the security infrastructure, groundwater monitoring of OBP #2 was not feasible until the PA was eliminated. Groundwater and soil were subsequently sampled and elevated concentrations of VOCs were observed. This led to the source removal action that addressed elevated concentrations in the soils. HRC was added to the backfill to enhance biodegradation of residual VOCs (K-H 2005b). Although not scheduled for routine RFLMA monitoring, to assist the continuing assessment of the effects of HRC on water quality in this area Evaluation well 91105 was sampled in 2007.

Groundwater in the source area of OBP #2 was first monitored by well 91103, which was positioned within the subsequently remediated source area. Due to the elevated concentrations of VOCs reported in samples from this well and resulting concerns about the integrity of the polyvinyl chloride (PVC) of which this well was constructed, stainless-steel replacement well 91104 was installed 10 feet from the original well, still within the area that was remediated. Excavation of the source area then required abandonment of well 91104. Well 91105 was installed following completion of source removal activities, and is located a few feet downgradient of the downgradient edge of the source removal excavation, just under 75 feet

north-northeast from the location of former well 91104. As a result of the source removal, enhancement of biodegradation, and ultimate location of the replacement well, water quality in samples from well 91105 is not expected to closely resemble that in samples from former wells 91103 and 91104. Even so, for the time being the data are pooled.

The groundwater contaminant plume from OBP #2 flows generally north toward South Woman Creek/FC-4. As noted above in the discussion of the Mound Plume and associated MSPTS, adjacent to the OBP #2 source area was a 72-inch storm drain that potentially acted as a preferential groundwater pathway from the source area to South Walnut Creek. Previous work has shown the majority of this plume is captured by the MSPTS intercept trench (K-H 2005a). To further enhance this, following removal of the storm drain the resulting corridor was backfilled and a trench linking it to the MSPTS intercept trench was cut and backfilled with gravel, thereby diverting groundwater from the OBP #2 source area to the MSPTS for treatment (K-H 2005b).

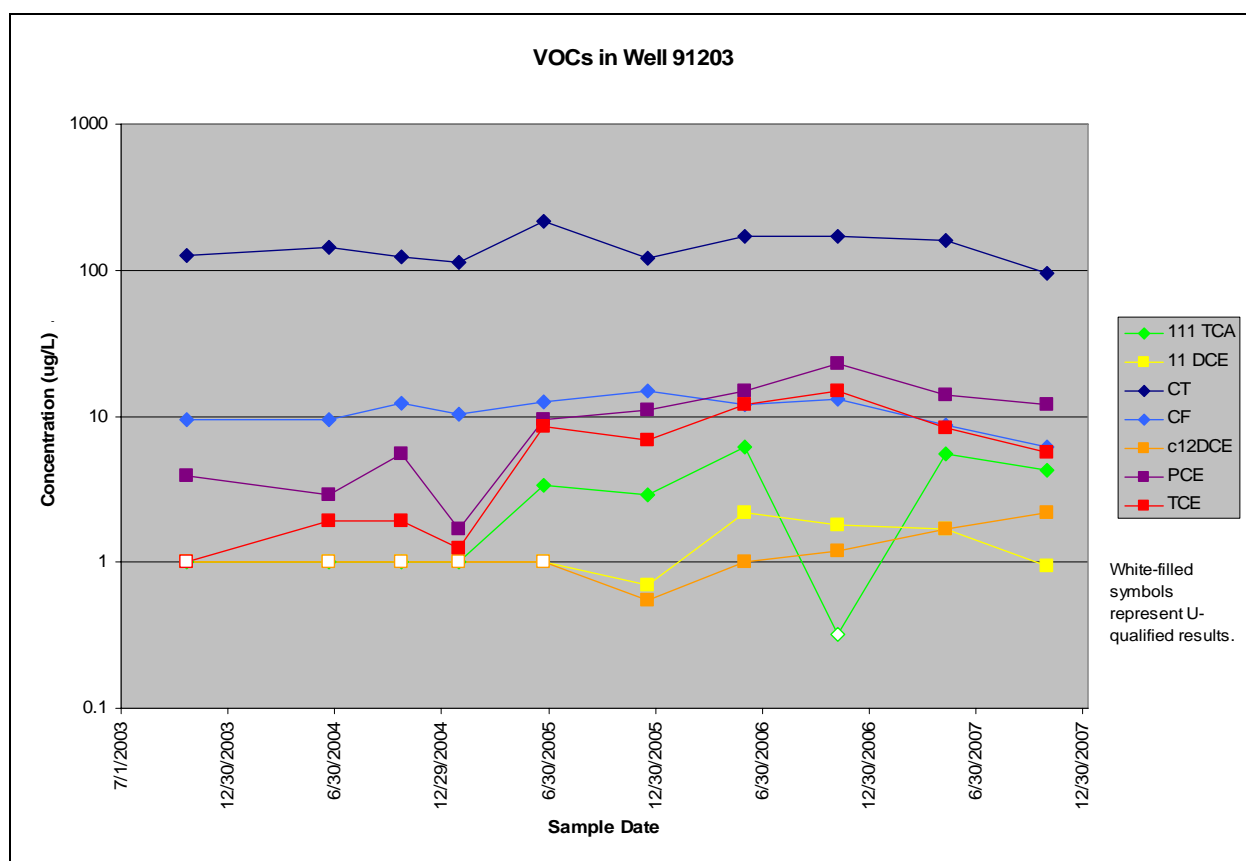
The main VOCs present in groundwater samples from the OBP #2 source area are displayed on the time-series plot on Figure 3-218. Evident on this figure are several patterns. First, although not necessarily meaningful, concentrations of the primary parent compounds (1,1,1-TCA, PCE, and TCE) were highest during the period in which the monitoring employed stainless-steel well 91104. More important from the perspective of Site closure is the fact that parent compound concentrations (especially PCE and TCE) decreased, while primary daughter product (cis-1,2-DCE, chloroform, and VC) concentrations increased following remediation of the source area. To some extent, this pattern must be an artifact of the well's relocation outside the source area (which was desired because there was little value in installing 91105 in clean backfill). Even so, the difference in relative concentrations among parents and daughters is probably a reflection of the source removal.



Notes: 111TCA = 1,1,1-TCA; 11DCE = 1,1-DCE; CT = carbon tetrachloride; CF = chloroform; c12DCE = cis-1,2-DCE; VC = vinyl chloride. RFLMA surface-water action levels for these constituents (µg/L; DOE 2007d): 1,1,1-TCA, 200; 1,1-DCE, 7; CT, 5; CF, 3.4; cis-1,2-DCE, 70; PCE, 5; TCE, 5; VC, 0.2. Concentrations of VC prior to the 2007 result are not illustrated because they are all nondetects (detection limit ranged from 1 µg/L to 68 µg/L). In addition to the nondetects (U-qualified results) that are illustrated, several other results were qualified (J, D) but are not shown differently for the sake of simplicity. Well replacement dates are noted on the figure; original PVC well 91103 provided samples from the contaminated source area through June 21, 2004; stainless-steel replacement well 91104 provided subsequent samples from the contaminated source area through January 26, 2005; OBP #2 was remediated and replacement well 91105 installed as shown, providing the balance of the samples. Note logarithmic scale for concentrations.

Figure 3-218. Concentrations of VOCs in OBP #2 Source Area Well 91105

With the exception of VC, which is not detected, the same compounds are displayed on Figure 3-219 for Sentinel well 91203, located north of the OBP #2 source area (Figure 3-202). Samples from this well show an increase in some parent compound concentrations (particularly PCE, TCE, and 1,1,1-TCA) coinciding with the disruption associated with remediation of OBP #2 completed on April 1, 2005. Concentrations of carbon tetrachloride and chloroform also show a shorter-term increase. These patterns suggest that, while groundwater at well 91203 is not strongly impacted by the OBP #2 source area, it does receive some input from that area.



Notes: 111TCA = 1,1,1-TCA; 11DCE = 1,1-DCE; CT = carbon tetrachloride; CF = chloroform; c12DCE = cis-1,2-DCE. RFLMA surface-water action levels for these constituents (µg/L; DOE 2007d): 1,1,1-TCA, 200; 1,1-DCE, 7; CT, 5; CF, 3.4; cis-1,2-DCE, 70; PCE, 5; TCE, 5. In addition to the nondetects (U-qualified results), several other results were qualified (J, D), but are not shown differently for the sake of simplicity. Note logarithmic scale for concentrations.

Figure 3-219. Concentrations of OBP #2 VOCs in Downgradient Well 91203

Data from well 91305, located west of well 91203, suggest the OBP #2 source area does not contribute significant quantities of groundwater to this well. Concentrations of cis-1,2-DCE and VC have been frequently reported in samples from well 91305. This differs from results for samples collected from the predecessor well, 2187 (which was located almost 60 feet north), as these constituents were reported as nondetects. For the two sets of groundwater samples collected in May and November 2007, respectively, the concentrations of cis-1,2-DCE were reported at 9.6 µg/L (estimated) and 7.6 µg/L; concentrations of VC were reported at 0.49 µg/L (estimated) and nondetect.

S-K trend calculations suggest several trends for contaminants reported in groundwater samples collected from well 91203 (Table 3-86). Cis-1,2-DCE has an increasing trend at a 95 percent confidence level; however, the trend may not be valid due to numerous nondetects in the data set. Other trends are also suggested but at a lower confidence level. Refer to Appendix B.3 for the S-K plots and detailed summary tables.

IHSS 118.1 (Carbon Tetrachloride) Plume

The area referred to as former IHSS 118.1 is the source of a carbon tetrachloride plume. In late 2004, the dense, nonaqueous phase liquid source material was removed along with an adjacent

subsurface tank group referred to as B730. HRC was added to the backfill material to enhance biodegradation of residual contamination.

Evaluation well 18199 is located immediately north of the former IHSS, roughly 80 to 90 feet north-northwest of the area in which free-phase carbon tetrachloride was present and perhaps 30 feet north of the source-removal excavation boundaries. Although not scheduled for RFLMA sampling in 2007, to support the continuing assessment of the effects of HRC the well was sampled.

Concentrations of carbon tetrachloride and chloroform, the primary contaminants in this well, appear to be decreasing in the sample collected in 2007 relative to those reported in prior years. Time-series plots are presented on Figure 3-220. Additional samples will be required to confirm whether this decrease represents the start of a trend.

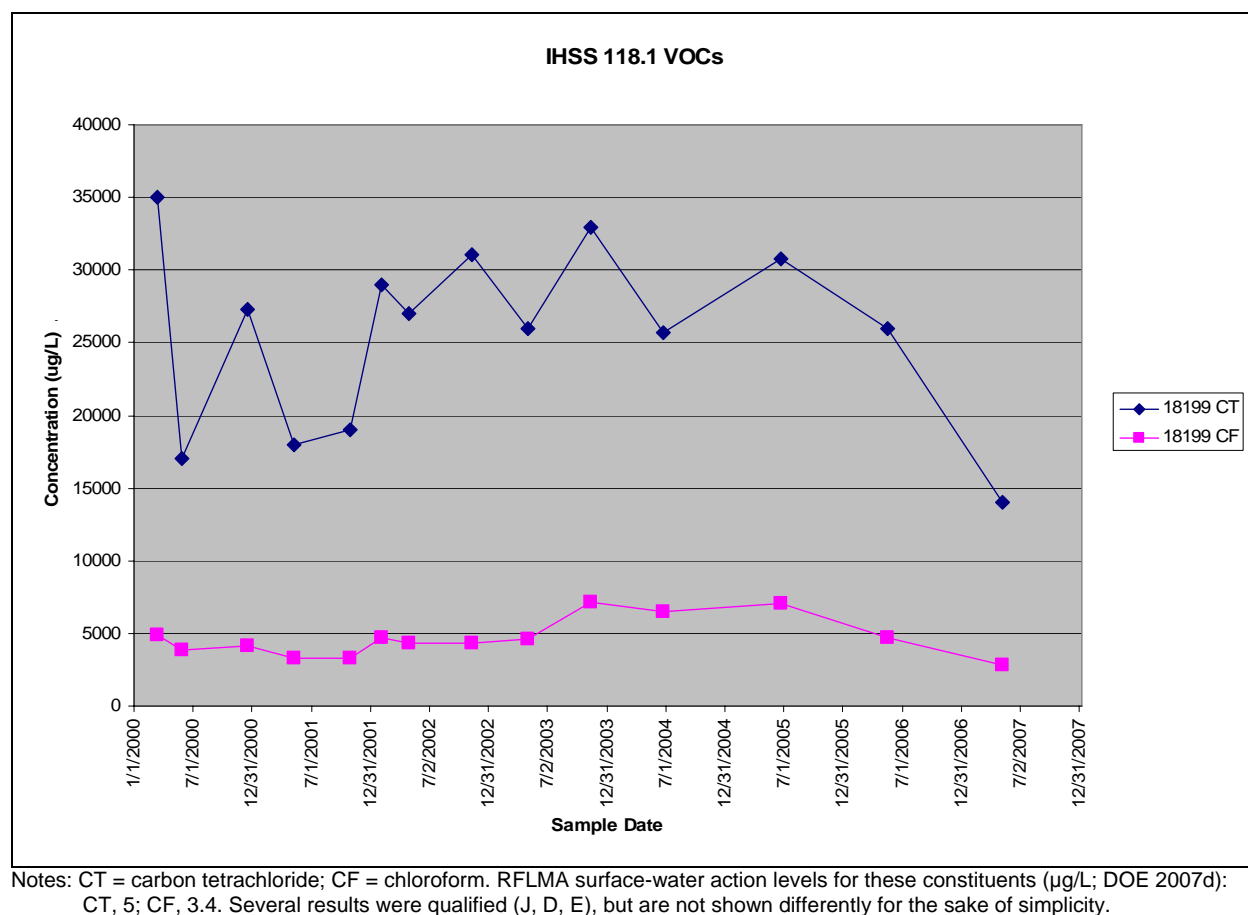


Figure 3-220. Concentrations of Primary IHSS 118.1 VOCs in Source Area Well 18199

Concentrations of methylene chloride, another breakdown product of carbon tetrachloride, are also reported in samples from well 18199 but are not shown on Figure 3-220 because of the frequent B qualifiers (indicating laboratory contamination from this common lab solvent). Also not shown are PCE and TCE concentrations, which are relatively low compared to those of carbon tetrachloride and chloroform (i.e., PCE is reported at well under 100 µg/L, and the most common result for TCE is nondetect).

Water-quality data from wells 20705, 20505, and 20205, all of which are located generally north of IHSS 118.1 and former B771, will also continue to be assessed to determine whether a more northerly groundwater flow path is indicated. Such a path is not suggested by data collected in 2007, which are generally consistent with pre-closure results. As noted in Table 3-86 and Appendix B.3, S-K trend calculations indicate statistically significant (95 percent) increasing trends in cis-1,2-DCE and U concentrations at well 20705; however, the VOC data are complicated by the presence of many nondetects and the U data may be affected by the well replacement. The highest U concentrations are an order of magnitude lower than the U threshold defined in RFLMA. Note that well 20505 is also reported (Table 3-86) as suggesting an increasing trend in 1,1-DCE, although at less than a 95 percent significance—and of the nine results available since 2000, five represent estimated concentrations, three are nondetects, and only one is an unqualified detection, further casting doubt on the validity of such a trend.

PU&D Yard Plume

The PU&D Yard Plume is an area of groundwater with low concentrations of primarily PCE-family VOCs. This area was the site of the first HRC application performed at Rocky Flats, which took the form of a treatability study performed in early 2001 (K-H 2001b, 2002; see K-H 2005a for final detailed information from this study). This plume is monitored by Evaluation well 30900 in the source area and Sentinel well 30002 to the east, at the margin of North Walnut Creek. In addition, PLF RCRA wells 70393 and 70693 monitor the northern edge of this plume.

Evaluation well 30900 was not sampled in 2007, but Sentinel well 30002 and RCRA wells 70393 and 70693 were sampled. No VOCs were detected in either of the semiannual samples collected from Sentinel well 30002. RCRA wells 70393 and 70693, which are sampled quarterly, both reported consistent detections of VOCs including 1,1,1-TCA, 1,1-DCE, PCE, and TCE. Only TCE concentrations in samples from well 70393 exceeded the RFLMA Table 1 standards. Concentrations of TCE were very uniform, ranging from 8.3 µg/L to 8.7 µg/L in the four samples collected in 2007; the Table 1 standard is 5 µg/L (DOE 2007d). As summarized in Table 3-86 (see also Appendix B.3), the S-K trend calculations indicate concentrations of TCE in samples from well 70393 are decreasing at the 95 percent confidence level.

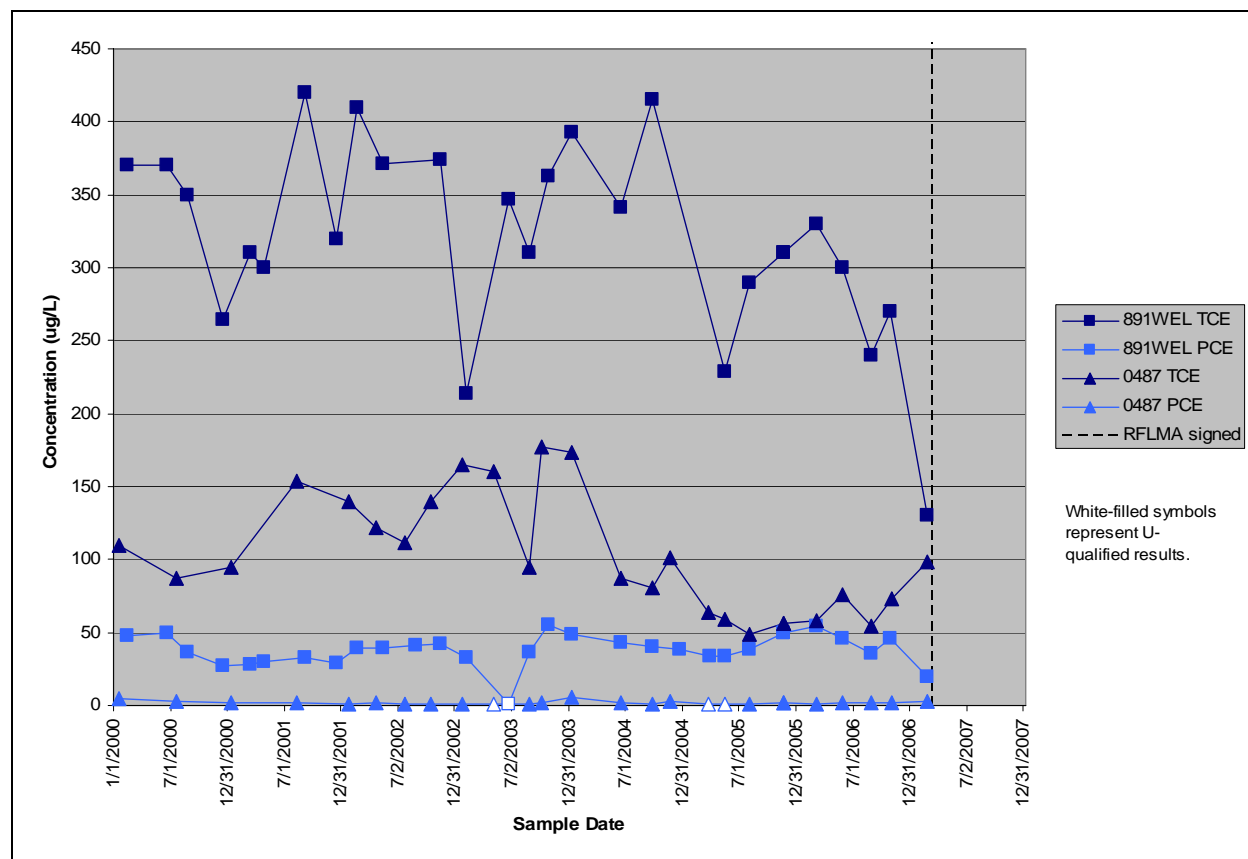
Other compounds, including carbon tetrachloride, chloroform, cis-1,2-DCE, and ethylbenzene were each reported inconsistently, and at J-qualified (estimated) concentrations that all were less than 1 µg/L. Refer to the quarterly reports for 2007 (DOE 2007g, 2007h, 2008a) and Appendix B for analytical data.

OU 1 Plume

The OU 1 Plume is located on the 881 Hillside, immediately south of the former IA. Its source area, former IHSS 119.1, was a drum and scrap metal storage area. Wells monitoring this plume were sampled prior to March 14, 2007, according to the OU 1 CAD/ROD (DOE 2001), which specified that six wells be monitored on set monitoring frequencies ranging from quarterly to semiannually. In first quarter CY 2007, the two quarterly monitored wells, 891WEL and 0487, were sampled. With the signing of RFLMA, the former well is reclassified as an Evaluation well

and the other wells previously monitoring this plume (including 0487, 4787, 4887, 10992, and 11092) are no longer monitored. Reporting on this plume has changed accordingly.

Concentrations of TCE, the constituent of greatest historic interest in this plume, appeared to decrease somewhat in the samples collected from source-area well 891WEL in first quarter CY 2007, compared with previous results (Figure 3-221). This plume is also monitored by AOC well 89104, located to the south adjacent to Woman Creek (Figure 3-202). No VOCs were detected in either sample collected from this well in 2007.



Notes: RFLMA surface-water action levels for these constituents (ug/L; DOE 2007d): TCE, 5; PCE, 5. In addition to the nondetects (U-qualified results), several other results were qualified (J, D), but are not shown differently for the sake of simplicity. With the signing of RFLMA, well 891WEL was reclassified as an Evaluation well (sampled biennially) and well 0487 was removed from the monitoring network.

Figure 3-221. Concentrations of Primary OU 1 VOCs in Source Area Wells 891WEL and 0487

Other Areas

Although not marked by plumes, other areas warrant mention either because associated wells have produced samples with concentration trends having a 95 percent significance or because they may be of interest. These are summarized below.

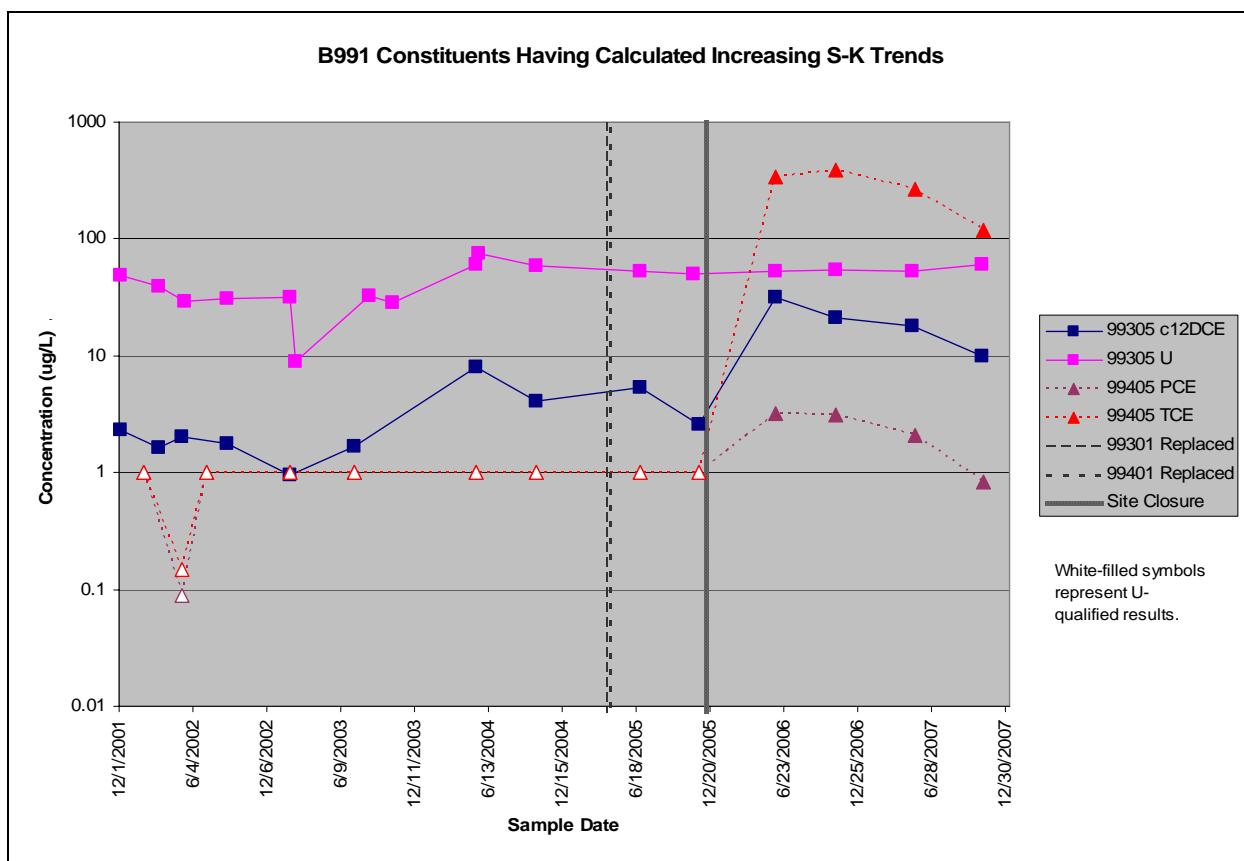
East Government property boundary: Boundary wells 10394 (Woman Creek and Indiana Street) and 41691 (Walnut Creek and Indiana Street) were sampled in 2007 and results were consistent with previous data. Constituents that were detected at 10394 included nitrate and U; at 41691, only U was detected. S-K trend calculations indicate two significant (at 95 percent level) trends

in groundwater at these locations: a decreasing trend in U at 10394, and an increasing trend in U at 41691. The latter may be related to the elimination of the large volume of imported water that previously flowed off site (via pond discharges) and therefore was previously available to recharge groundwater along Walnut Creek prior to closure. This water would have acted to reduce the U content of the groundwater. Increasing U concentrations now may reflect the groundwater regime seeking to reestablish a natural geochemical equilibrium.

Former B991: Wells 99305 and 99405 have both reported detections of VOCs at higher concentrations than were typical prior to closure. S-K trend plots show 95 percent confidence in the calculated increasing trends in cis-1,2-DCE at well 99305, PCE at well 99405, and TCE at well 99405. In addition, an increasing trend is indicated for U at 99305. Both of these wells were located off the east edge of B991, with well 99405 positioned in the east loading dock area. As shown on Figure 3-222, these water-quality changes occurred suddenly, particularly with respect to TCE in groundwater collected from well 99405. The apparent trend in the results reported after this initial increase appears to be toward decreasing concentrations of each of the VOCs. Most importantly, only TCE in well 99405 is reported at concentrations exceeding the RFLMA action level of 5 µg/L. See previous quarterly and annual reports (particularly DOE 2006g, 2007e, 2007h) and Appendix B for details on the analytical data.

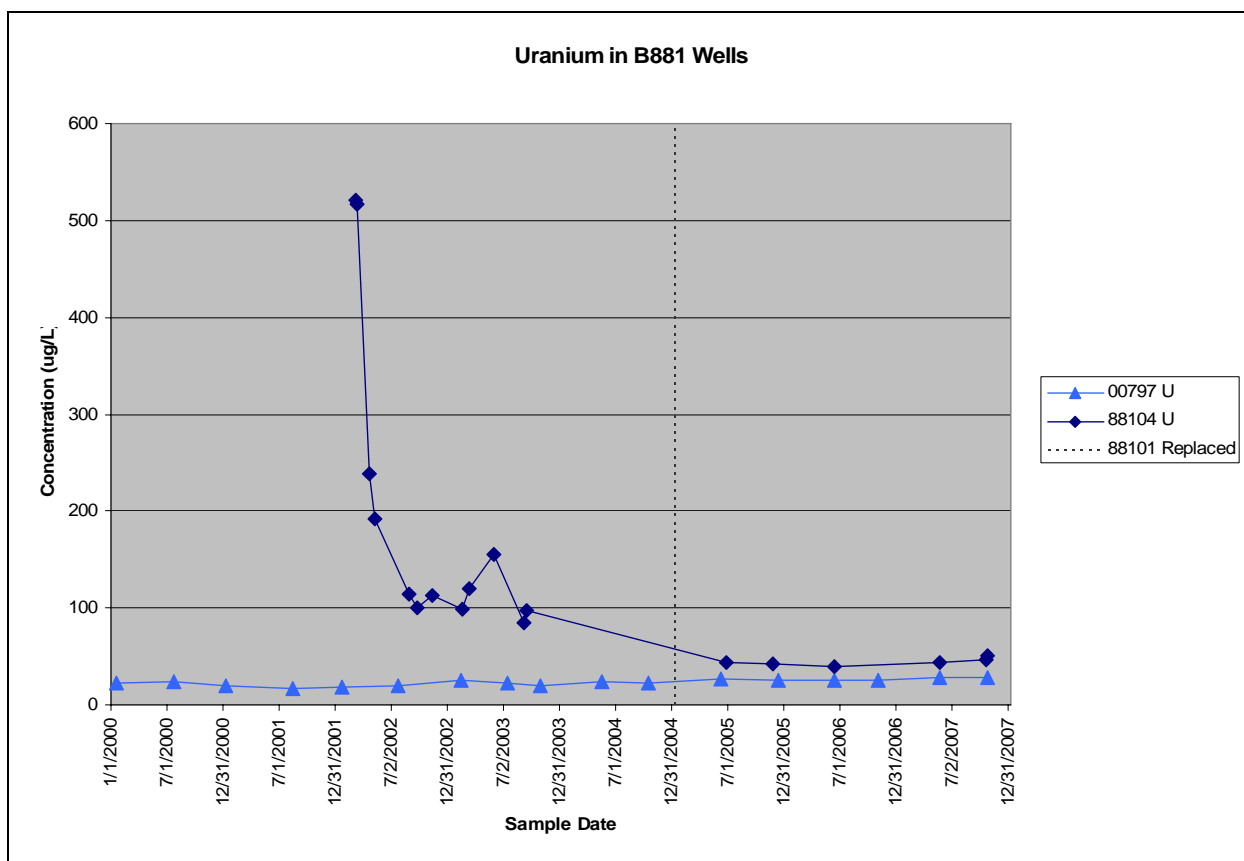
Also shown on Figure 3-222 are the dates of the well replacements, when well 99301 was replaced with 99305 and well 99401 with 99405, and Site closure. This clarifies that the changes in water quality do not appear to be a result of well replacements, but rather activities performed to close the Site. As noted above, VOC concentrations in grab samples from downgradient surface-water location GS10 have been below RFLMA standards.

Former B881: As noted in the 2006 Annual Report (DOE 2007e) and Table 3-86, the trend for U in well 88104 is decreasing, while in well 00797 it is increasing. The trend calculated for well 88104 is complicated by the well replacement performed in 2004, when well 88101 was replaced with well 88104, the latter of which was located approximately 110 feet south of the original location. Figure 3-223 illustrates U concentrations in these two wells since 2000, and clearly shows the difference in U concentrations between the original well, 88101, and replacement well, 88104. Also evident is the relatively uniform concentrations of U in groundwater samples from well 00797; the increasing trend has a very slight positive slope (calculated to be 1.167; see the S-K plots and summary tables in Appendix B.3). Note that concentrations of U in both wells are and have been below the RFLMA U threshold of 120 µg/L (DOE 2007d) since before B881 was demolished.



Notes: c12DCE = cis-1,2-DCE. RFLMA action levels for these constituents (ug/L; DOE 2007d): cis-1,2-DCE, 70; U (threshold), 120; TCE, 5; PCE, 5. In addition to the nondetects (U-qualified results), several other results were qualified (J, B, N), but are not shown differently for the sake of simplicity. U data include results for U-mass and converted isotopic activities. Note logarithmic concentration scale.

Figure 3-222. Concentration of Constituents With Increasing S-K Trends in B991 Wells



Notes: RFLMA U threshold is 120 ug/L (DOE 2007d). Several results were qualified (J, E, B, N), but are not shown differently for the sake of simplicity. U data include results for U-mass and converted isotopic activities.

Figure 3-223. Concentration of Constituents With Increasing S-K Trends in B881 Wells

3.1.5.4 Other Water-Related Issues in 2007

This section summarizes some of the more notable events, activities, and conditions related to groundwater at the RFS in 2007.

Reportable Condition: Nitrate at AOC Well B206989

Well B206989 entered a reportable condition in 2007 due to the presence of nitrate in groundwater at concentrations exceeding the applicable standard in RFLMA. This condition was set up by the well being reclassified via RFLMA from a Sentinel well to an AOC well. (The former classification has no reportable conditions, while the latter does.) This reportable condition was anticipated, because the well produces groundwater samples that are consistently above the nitrate standard (10 mg/L in No Name Gulch, where the TM does not apply).

Results for the first sample collected subsequent to the well being reclassified was above the standard. Decision rules for AOC wells define a reportable condition as existing when two consecutive, routinely collected (i.e., per the frequency stated in RFLMA) samples each contain concentrations of the constituent of interest at levels above those presented in RFLMA Attachment 2, Table 1 (DOE 2007d). Technically speaking, this had not yet occurred, as only one such sample had been collected since the well was classified as an AOC well. However,

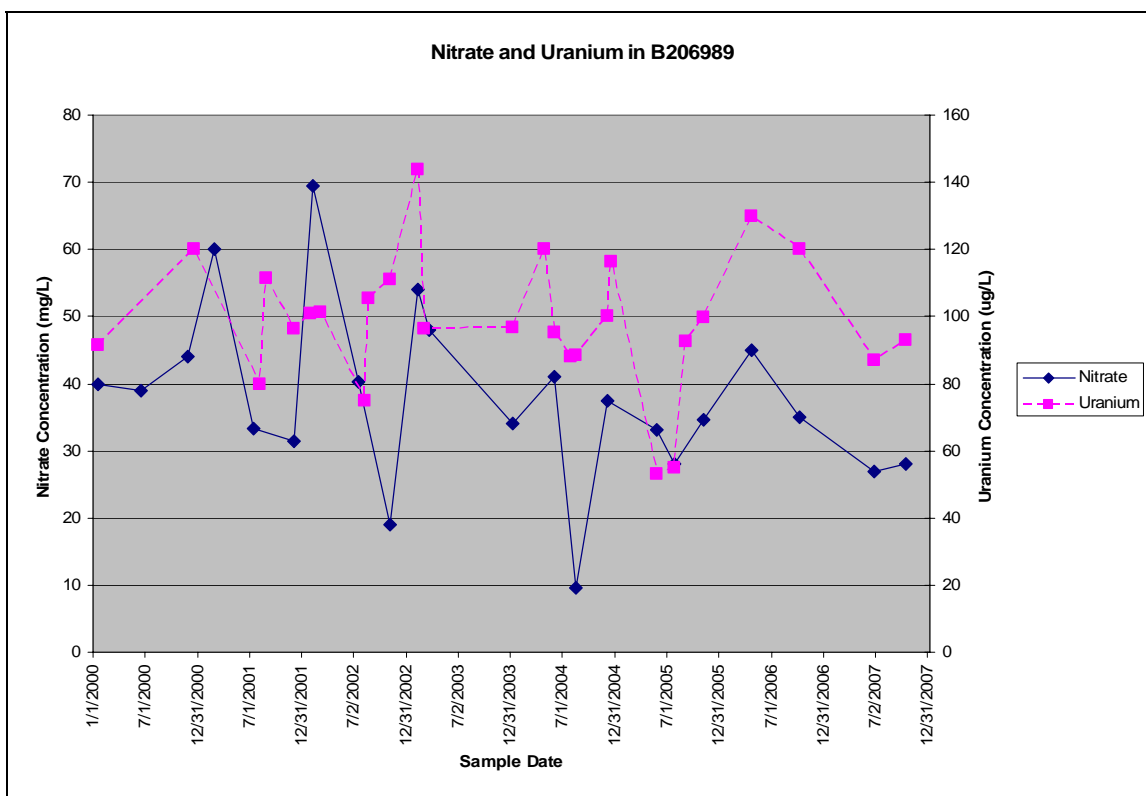
given the consistently elevated concentrations of nitrate in previous samples from well B206989 (since January 2000, only one sample had reported concentrations below the standard), a reportable condition was anticipated and declared upon the receipt of the sample collected in June 2007.

Following discussions with CDPHE, RFLMA Contact Record 2007-06 (see Appendix H) was finalized on October 12, 2007, documenting the agreement that was reached regarding nitrate in groundwater samples from well B206989. This contact record provided statistical evaluations of nitrate in samples from well B206989, which suggest that the concentrations of nitrate are decreasing. The level of confidence in these trends is not sufficient to conclude the trends are indeed decreasing, and therefore the contact record requires additional data be collected per RFLMA and assessed statistically.

Briefly summarizing, per the contact record, if the decreasing trend is confirmed at a confidence level of 80 percent or more, the evaluation shall terminate. (Until the evaluation terminates, additional samples that exceed the nitrate standard shall not constitute a new reportable condition.) If the trend appears to reverse, even at less than 80 percent confidence, or if an 80 percent confidence in the decreasing trend (full record or last eight routinely collected samples) is still not reached by the end of CY 2011, consultation shall ensue to determine the appropriate path forward. See the full contact record in Appendix H for details.

Note that the U concentrations in groundwater samples from this well are also occasionally above the applicable level, in this case the 120 µg/L total U threshold. Therefore, it is anticipated that a reportable condition may eventually apply for this constituent as well. However, because the threshold is not exceeded with the same regularity as is the 10 mg/L nitrate standard, a reportable condition for U has not yet been declared.

Figure 3-224 provides updated trend plots of nitrate and U in groundwater samples collected through the end of 2007 from well B206989. Updated S-K plots are provided in Appendix B.3, even though neither trend (both of which are apparently decreasing) is statistically significant at even the 80 percent level. (U is included for completeness, to illustrate its historical concentrations and provide some context for the possible future reportable condition for this constituent.)



Notes: The applicable action level for nitrate is 10 mg/L; that for U is 120 µg/L (DOE 2007d).

Figure 3-224. Concentrations of Nitrate and U in Groundwater Samples from AOC Well B206989

Slump South of B991

The slump south of former B991 was regraded in 2007 as discussed in detail in Section 2.7.2. Cracks suggesting the potential for slumping were first observed in January 2006, and the vertical and horizontal displacement was monitored thereafter.

Seeps were observed on the slump, predominantly in the eastern portion and around the eastern margins of the feature (Figure 3-225). As of the end of 2007, they had not reappeared. Figure 3-226 and Figure 3-227 provide photographs of the slump before its development, during a time of maximum displacement, and after the regrade was complete.

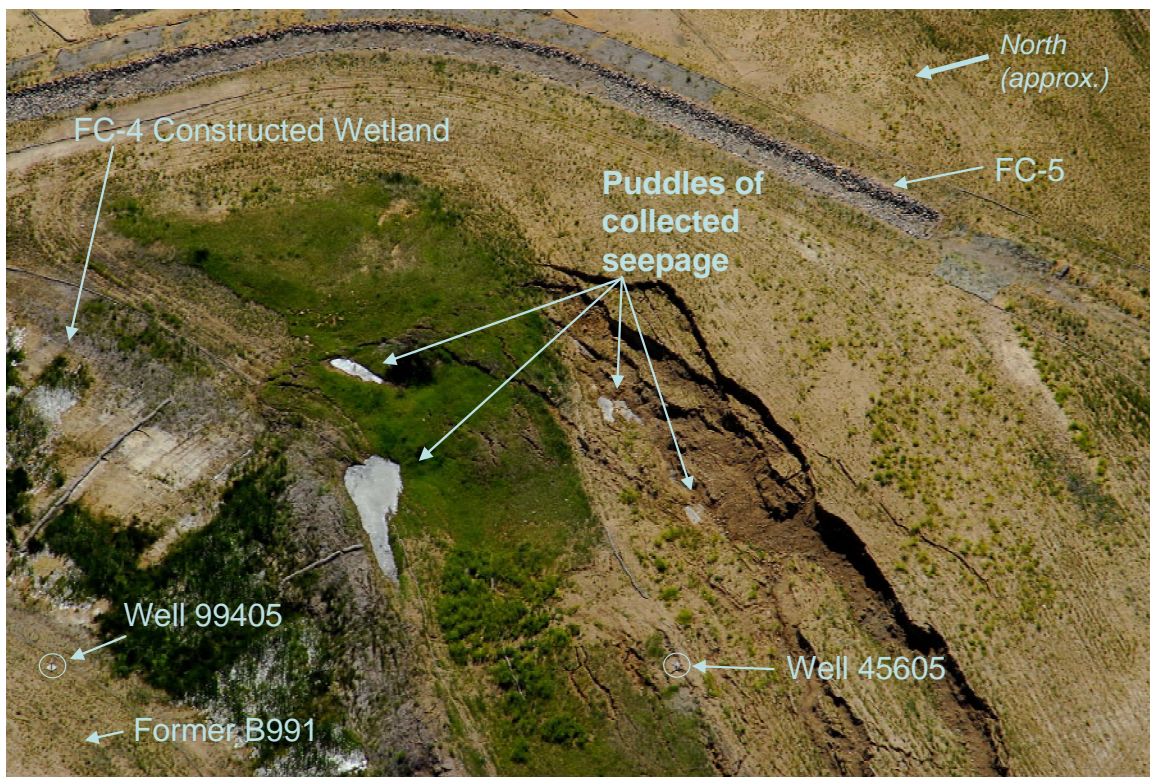


Figure 3-225. June 2007 Aerial Photo of Slump Showing Areas of Seepage

As previously noted, Sentinel well 45605 was abandoned to make way for the regrading effort. This well will be replaced in 2008. For additional information on the slump, refer to the 2006 annual report (DOE 2007e).



Top photo: Conditions on June 6, 2005. The constructed hillside is the area covered with green grass. Future FC-4 wetland is at its base, and former SW056 is located as shown. The site of former B991 is across (north of) FC-4 from the hillside and SW056, on the center-right edge of the photo. FC-5 (the line of gray riprap) enters from the left and joins FC-4 near the center of the photograph. Site closure activities are still in progress at this time, as indicated by the presence of heavy equipment and former B891 in the background. Bottom photo: Conditions on September 26, 2007, just prior to the start of regrading activities.

Figure 3-226. Photographs of Hillside Before and After Slump Development



Regraded slump on January 7, 2008. The replacement for well 45605 will be installed in the bench midway up the slope (marked by a long strip of snow below the line of trees). Note that the Russian olive tree that had been present near the western end of the slump (toward the right in this and the preceding pictures) was also removed during the regrade.

Figure 3-227. Photograph of Regraded Slump

Abandonment of Well 45605

As noted above, the hillside in which Sentinel well 45605 was installed developed into a slump beginning in January 2006 (the first instance in which surface cracks were observed). This caused damage to the well.

On October 1, 2007, the fourth-quarter CY 2007 sampling event at this well was successfully performed, and on October 18 the well was abandoned in place. Due to the kinked condition of the well casing, the depth of the well could not be measured at that time. The 1-inch PVC well casing was filled with sand and clay (granulated bentonite) per State requirements (State of Colorado 2005), although this activity was also hampered by the condition of the well. The upper 5 feet of casing was removed and the remaining borehole filled to surface with granulated bentonite.

Additional PVC well casing was subsequently removed as the hillside was regraded by heavy equipment. However, the length of additional casing removed was not documented.

Well 45605 will be replaced before the end of second quarter CY 2008 to ensure it is available for routine sampling on the normal semiannual schedule for Sentinel wells. The objectives of the original well will apply to the replacement well (see DOE 2007e for a description of the location-specific objectives). The well will be developed prior to sampling. The location of the replacement well will be approximately 5 to 10 feet west of the surveyed location of well 45605

(i.e., upgradient, along remnants of the buried French drain). The replacement well will be identified as Sentinel well 45608.

SPPTS Treatability Studies

As reported in the 2006 Annual Report (DOE 2007e), treatability studies of the SPP water began in 2006 but were not successfully completed. A revised set of studies was performed in 2007, fulfilling one of the recommendations made in the CERCLA 5-year review (Section 2.2). Appendix G includes the full report on these studies; a brief summary is provided here.

The treatability studies were designed to test different substrates and carbon sources for microbiological denitrification of nitrate-contaminated water from the SPP. These studies were performed by researchers from Colorado State University. Substrates were selected to represent an inexpensive and readily available, high-surface area material (pea gravel), and a purpose-built, high-surface area material (a plastic environmental media called NorPak, manufactured by Jaeger Environmental). Carbon sources that were tested in a preliminary phase included ethanol and methanol. (In comparison, the current SPPTS uses sawdust as a combined substrate/carbon source, with 10 percent ZVI mixed in.)

This second round of studies began in spring 2007. The first step of this second phase focused on a matrix of laboratory batch tests to evaluate and compare different microbial inocula (sewage sludge, manure, and soil), water additives (such as phosphate and yeast extract), and carbon sources (ethanol, methanol, and corn syrup). The blend that was selected for use in the larger-scale barrel tests was sewage sludge with minor soil added (the soil was from the DG area), no water additives (except phosphate during the initial inoculation/acclimation period), and methanol as a carbon source.

Barrel (or “reactor”) tests were then performed using these components shared between one reactor with a pea-gravel substrate and one with the plastic NorPak substrate. The reactors and a holding tank, from which water could be metered at a constant rate, were installed within the SPPTS structure (Figure 3-228).



Notes: Water was routed from SPIN (collection well) to yellow vessel on left, from which it was metered at a constant flow rate to each of the two reactors. The larger reactor in the background was filled with pea gravel; the smaller reactor in the foreground was filled with the engineered plastic media. All effluent was then routed back into the SPPTS, via the Cell 1 influent vent riser (gray vertical pipe to right of the reactors) to ensure complete treatment. Before initiating the treatability studies, all components (reactors, holding tank) were buried in wood chips. See Appendix G for full report.

Figure 3-228. Photograph of 2007 SPPTS Treatability Study Apparatus

Water from SPIN was first used in the study, and was fed through the reactors at a rate of 50 milliliters per minute (mL/min) with a methanol application rate of 0.8 mL/min (approximately 1.6 percent of the total flow). Treatment was effective within 3 weeks after the study began. (The delay was due to the need for the bacteria to attach to the substrate and become acclimated to the reactor environment.) The hydraulic residence time was determined to be approximately 37 hours in each reactor.

Water from the DG was then used in the study, at the same flow and methanol application rates as were used for the SPIN water. It was successfully treated with no lag time—the bacteria had already acclimated to the reactor environment.

Optimization tests were then run, in which the methanol feed rate was reduced by one half and/or the influent flow rate was doubled. It was determined that the SPIN water could be treated at the lower methanol rate with minimal ill effects; however, the higher flow rate resulted in a significant decrease in nitrate removal. When both changes were made (halved methanol, doubled flow rate), the effluent contained excessive nitrate (i.e., above the TM). Water from the DG was not tested for optimization, but it is likely that incomplete treatment would have resulted. This is based on the water quality of these two waters, with the SPIN water averaging approximately 300 mg/L nitrate (as N) during the tests, and the DG water averaging roughly 500 mg/L nitrate (as N).

Analysis of U was also performed at several points in the studies, and as anticipated it was found that U was being removed from the water. Concentrations of U in SPIN water was reduced from 55 µg/L to 3.5–13 µg/L, depending on the reactor. Concentrations of U in DG water were

reduced from 68 µg/L to 24–36 µg/L, again depending on the reactor. (The gravel-filled reactor was more efficient at removing U, presumably due to the mineral surfaces available for sorption that were not present in the plastic-filled reactor.) The studies were designed to evaluate removal of nitrate, so the fact that U was not removed to the same extent should not be seen as a flaw in the treatment method.

Although the treatability studies successfully demonstrated that adequate water treatment could be achieved using the selected inocula, methanol as carbon source, and either type of solid support material tested, significant deviations from results that were anticipated based on current literature were evident. In particular, the stoichiometric requirement for methanol was calculated to be approximately 0.16 percent by volume (0.08 mL per 50 mL, or one-tenth that used in the studies). However, while influent and effluent nitrate concentrations were essentially equivalent between the two reactors, the concentrations of residual methanol in reactor effluents were variable, suggesting incomplete mixing took place within the reactors. In addition, when the reactors were dismantled for demobilization it was found that the expected biofilm was restricted to the “upstream-most” portion of each reactor, suggesting incomplete distribution of the denitrifying bacteria. Had the bacteria been thoroughly distributed and flow been uniform through the reactors, more efficient treatment would have resulted. This was partly a factor of reactor size and study duration. Shortcutting would be less likely through a larger-scale system, and the bacteria would be distributed throughout over a longer time period than was available to the studies. Bacterial distribution could also have been improved had the inoculum been recirculated for a longer time through each reactor; this took place for 4 days during the studies, but results suggest that time should have been increased to at least 2 weeks or so.

See Appendix G for the full report on these treatability studies, and DOE (2007e) for the report on the first set of studies (performed in 2006).

SPPTS DG Flow Measurement and Potholing

Treated effluent from the SPPTS is routed through a perforated segment of the pre-existing Interceptor Trench System (ITS) to the point where it is diverted through a newer, nonperforated pipe and discharges to the subsurface. A portion of this subsurface discharge eventually is present as surface flow that is monitored at the SPP DG. Since installation of the SPPTS in 1999, water quality measured at the DG has shown that additional nitrate and U impacts the effluent between the point where it exits the treatment system (and is clean) and the DG.

Two activities were undertaken in 2007 to better understand conditions at the DG. First, a temporary flume was installed at the DG in April 2007. Flow measured at this location does not represent all flow discharged to the subsurface. This is because the discharge pipe is buried and inaccessible. Only that portion of the flow that eventually reaches the surface and flows through a small channel to the flume is measured. The fraction of the total flow that is measured is not known; however, because of the saturated ground and lush vegetation between the discharge location and the flume, it is certain that some discharge goes unmeasured. Even so, it was found that under baseflow conditions (i.e., not storm surges), flow measured at the DG is on average approximately two and one-half times the flow measured at system effluent location SPPMM01 (Figure 3-229).

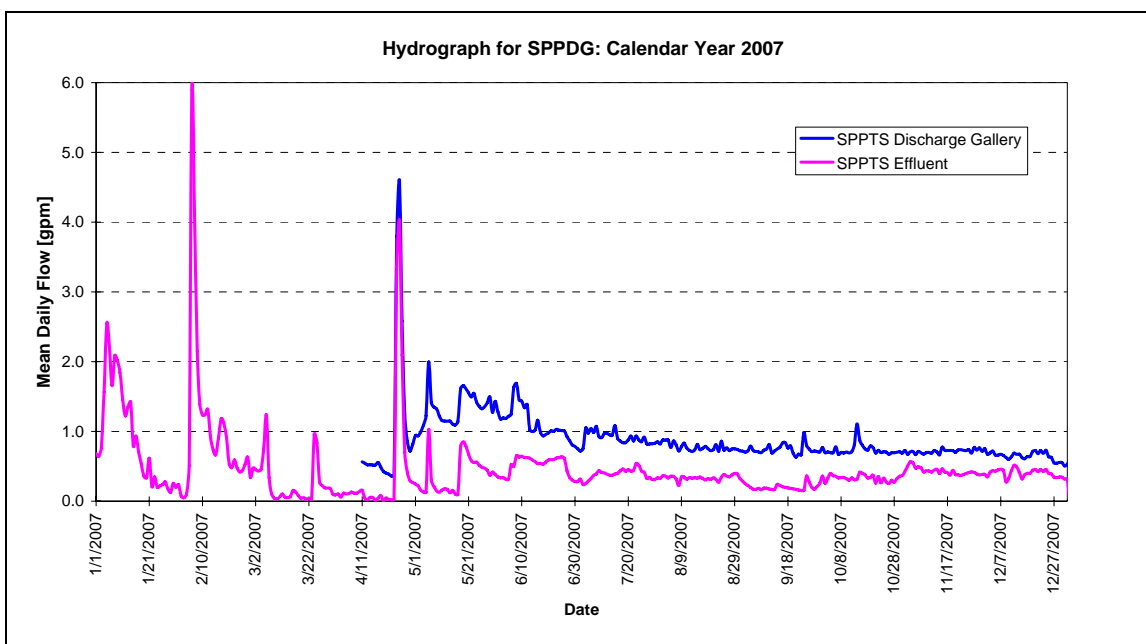
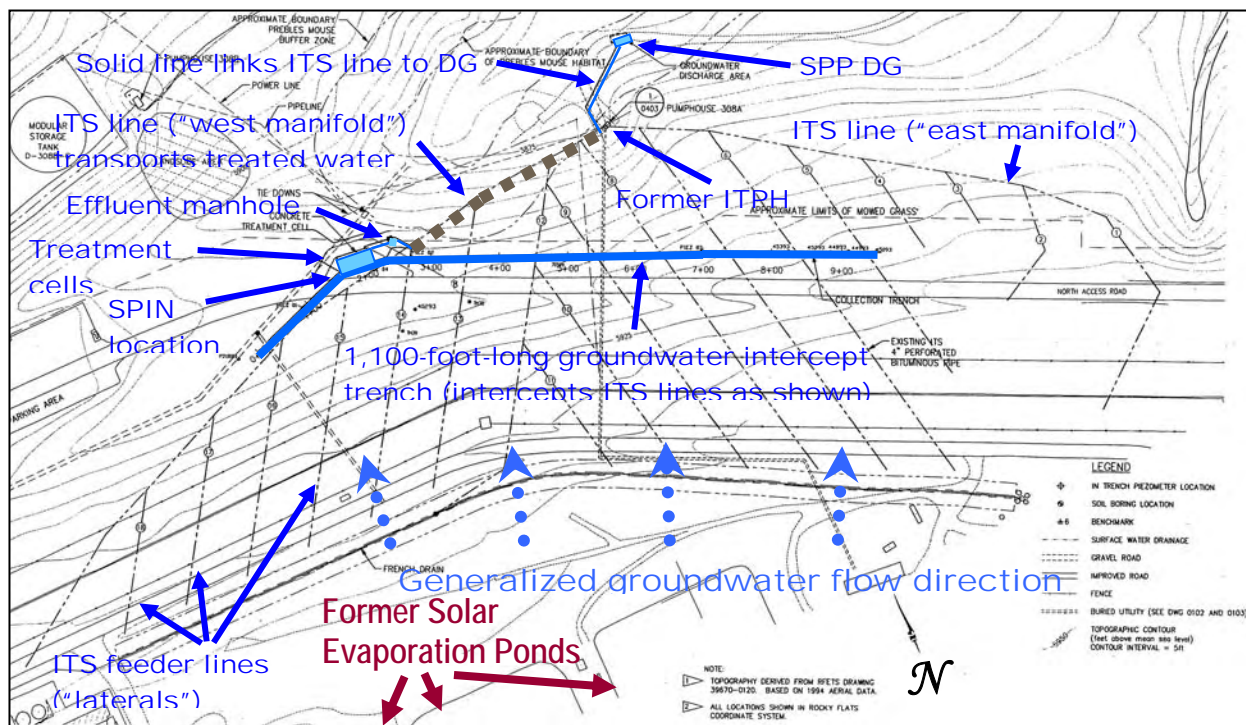


Figure 3-229. Flow Measured at SPPTS Effluent and DG Locations

Following this, exploratory excavations, or potholes, were dug to intercept the ITS east and west manifolds to evaluate water quality in each, and determine which might be contributing to higher concentrations detected at the DG. These are the two northernmost lines of the ITS; they are fed by the herringbone array of ITS “laterals” and previously emptied collected water to the former Interceptor Trench Pump House (ITPH, which was demolished as part of closure). These components are illustrated on Figure 3-230.



Notes: North edges of SEPs are visible near the bottom of the drawing. The effluent manhole is referred to as sampling location SPPMM01. Water collects in the intercept trench, is pumped into the treatment cells, exits the cells and flows through the (perforated) ITS west manifold and into the (nonperforated) line linking the manifold to the DG, where it discharges to the subsurface.

Figure 3-230. Drawing of SPPTS and ITS Components

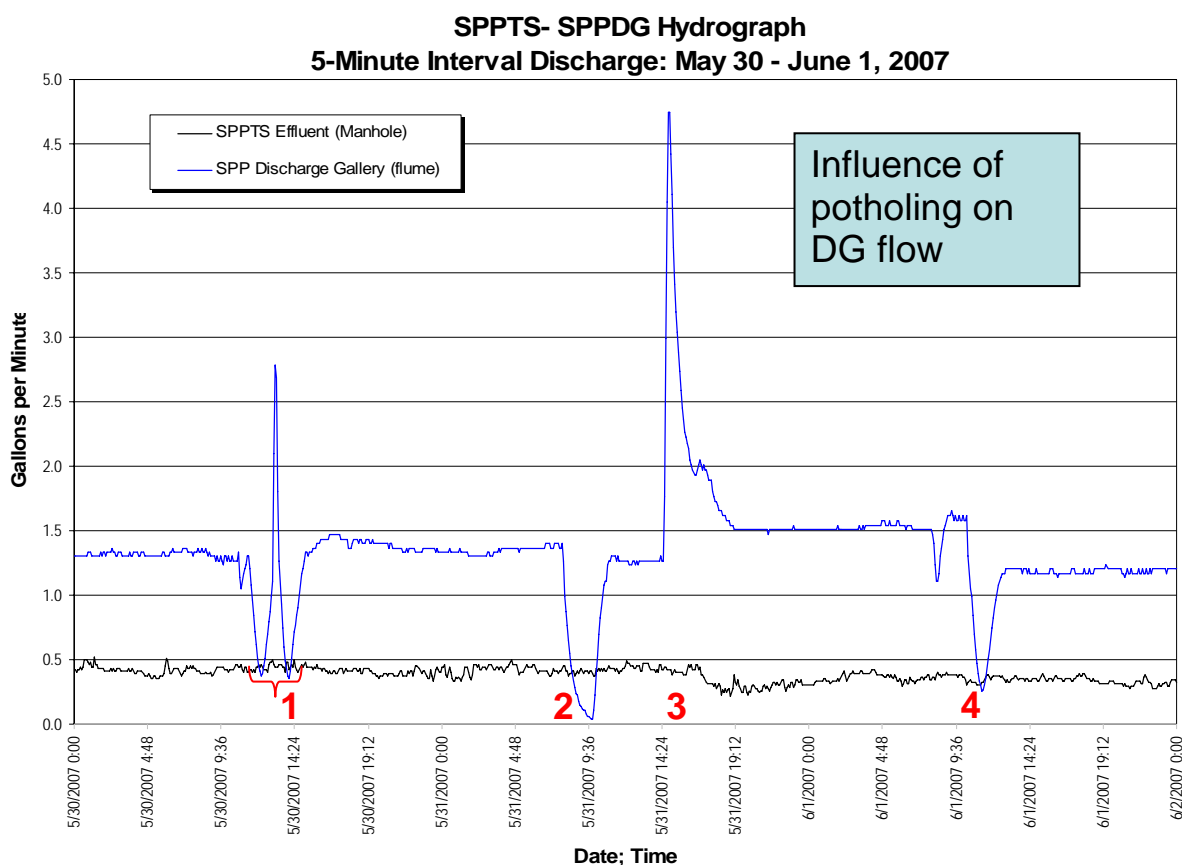
The west manifold pothole was dug at the point where the line to the DG joins the ITS line, and the east manifold pothole was dug at the point where the manifold penetrates the backfilled ITPH sump. When each of these lines was intercepted, flow rates were estimated and samples were collected.

Excavations of the ITS west and east manifolds revealed the lines at both locations to be under head due to their positions near the downhill end of the respective lines. In addition, the ITS east manifold was disrupted during the excavation. The next day, water was cleared out of the excavation and flow resumed from the pipe, but at a much lower rate than had been observed the previous day. Most of the flow at that time was observed to be coming from the remnants of the ITPH sump.

Table 3-93 summarizes events and observations during the excavation activities, and Figure 3-231 shows the effects of specific excavation activities on flow measured at the DG.

Table 3-93. Summary of Events During DG Excavations

Location	Date, Time	Samples (grabs)	Estimated Flow Rate	Comments
ITS west	5/31, ~0800	--	4 gpm	Flow under head; visual estimate of flow rate
ITS west	5/31, 0900	U, nitrate	1.2 gpm	Flow stabilized; average of three measurements
DG	5/31, 1030	U, nitrate	0.9 gpm	DG flow stopped as flow from loose coupling drained into excavation; resumed after coupling connection was completed, but not yet stable
ITS east	5/31, 1500	U, nitrate	50–60 gpm	Pipe disrupted on contact, flow under head; visual estimate of flow rate from pipe; sample from pipe flow
ITS east	6/1, 1045	U, nitrate	5 gpm	Cleared out excavation, flow resumed, rate stabilizing but still decreasing; visual estimate of flow rate from subsurface remains of ITPH; sample from this ITPH flow
DG	6/1, 1100	U, nitrate	0.5 gpm	Flow still varying somewhat due to excavation-related disturbances



Notes: ITS pot-holing timeline: 1. ITS west excavated and located, water drained from pipe into trench. 2. ITS west excavation cleaned out and sampled; flow subsided from ~4 gpm to stabilize at ~1 gpm (avg. 1.2 gpm, n=3). 3. ITS east intercepted and broken; initial flow ~50–60 gpm, sampled; job paused for safety. 4. ITS east excavation cleaned out, flow ~5 gpm and subsiding; sampled.

One interpretation: Confinement of pipe relieved at point 1, water flooded into trench. Trench reexcavated at point 2, again relieving confinement (this time from water pressure in the trench). At point 3, large volume of water in east manifold (which previously dead-ended in earth-filled sump, with water gradually percolating through to join flow to DG, but was broken during excavation work) flooded the excavation and short-circuited to DG, then flow stabilized. Clearing out the excavation at point 4 again reduced flow to DG as east manifold flow was diverted to refilling the excavation.

Figure 3-231. Annotated Summary of Flow Measured at DG During Potholing Activities

Analytical results (Figure 3-232) show concentrations in water samples collected from the ITS west manifold to be very similar to those in samples collected from the DG, while samples from the ITS east manifold contained much lower concentrations of both U and nitrate. Therefore, the source of the bulk of the contamination reported at the DG is the remnants of the west ITS manifold and associated laterals downgradient of the SPPTS interceptor trench.

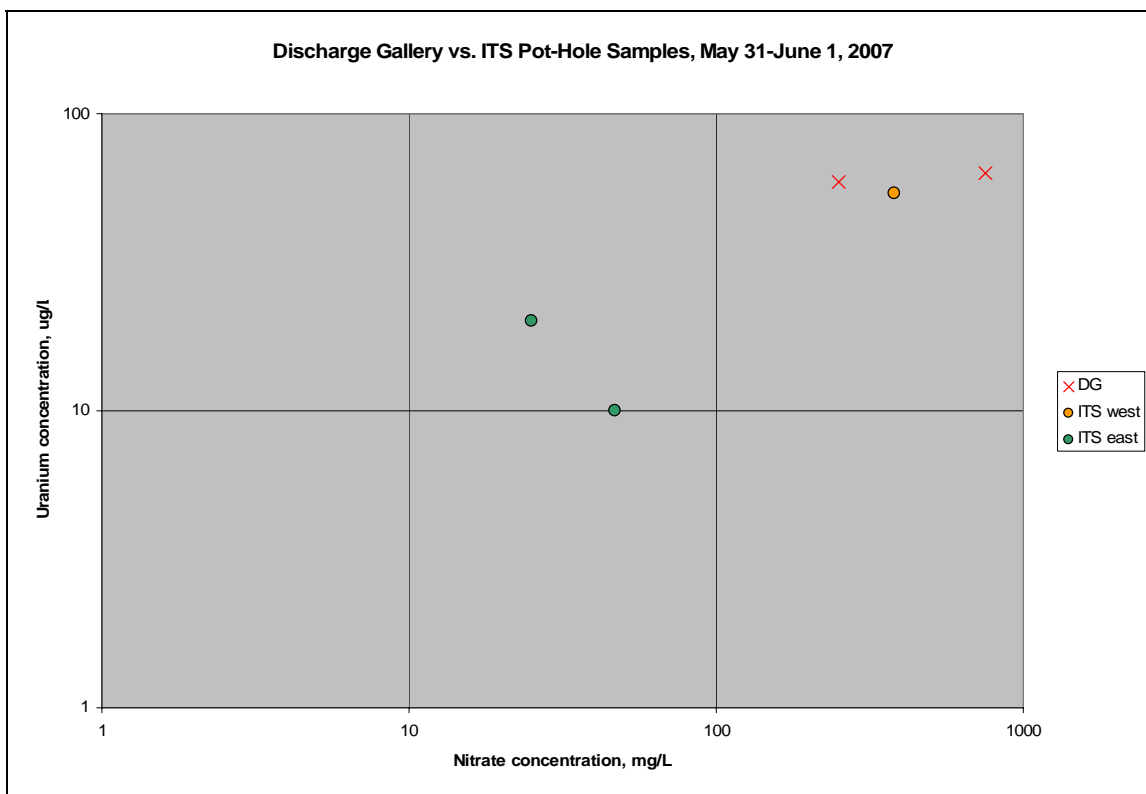


Figure 3-232. Analytical Data From DG and ITS West and East Manifold Samples

Updates to Groundwater Models

Prior to Site closure, numerous groundwater models were constructed (e.g., K-H 2004c) to support closure planning and decisions. These models also supported the design of the water monitoring network, helping to identify appropriate monitoring locations so that significant gaps in the network would not be present.

In 2007, several models were updated to assess general groundwater conditions and confirm they were consistent with pre-closure predictions. Models that were updated included the IA VOC Flow Model, the OLF Flow Model, and the Mound Site Flow Model. Each of the resulting memoranda reports on the updated models is included in Appendix F. It should be stressed that no contaminant models were updated, only flow components of these models. If the updated flow aspects of a model had shown unexpected groundwater flowpaths, for example, contaminant-related components of the model would have been updated as appropriate. However, groundwater flows agreed well with pre-closure predictions, so contaminant modeling was not performed.

In summary, the model updates found the monitoring network to be appropriately designed for its purpose. While additional data would be necessary to construct the sort of detailed models that were initially performed, existing data did not suggest the pre-closure predictions were inaccurate. Refer to Appendix F for the memoranda reports on these model updates.

No-Purge Sampling

Background

Groundwater at Rocky Flats is not plentiful, and wells in many areas dewater readily when purged. This is due to the semiarid climate (what groundwater is present does not receive abundant recharge), as well as the low-permeability materials in which most wells are installed (groundwater does not travel rapidly). With little recharge and slow-moving groundwater, wells tend to dewater readily and recharge may be a slow process, a condition that has hampered the groundwater monitoring program at Rocky Flats for decades.

After DOE-LM accepted control of the Site in late 2005, a study was begun to determine the feasibility of using a different sampling method at wells that typically go dry during the pre-sampling purge (even when purged using low-flow techniques). The purging activity is intended to remove stagnant water from a well so that the sample represents “fresh” formation water, with the understanding that the stagnant water may not be representative of the formation water (Puls and Barcelona 1996; EPA 2002; Cal/EPA 2006; Vandenberg and Varljen 2000). However, by purging extremely low-producing wells, often there is insufficient recharge to collect a sample within the allotted time (at Rocky Flats, samples for the analysis of VOCs must be collected within 48 hours after purging).

Well purging and sampling is a topic that has received much scholarly attention over the past several decades, and methods have improved greatly. The newer methods produce samples that are typically considered more representative of the formation water than do older methods. Even so, collecting representative samples from wells that go dry when purging is attempted remains a challenge. Dewatering the well (especially if done aggressively, either with a bailer or via higher flow-rate pumping) changes the geochemical conditions to which recharge is subjected, leading to recommendations against this approach (Barcelona et al. 2005; EPA 1998, 2002; Negrao and Kaminski 2007; Kaminski 2003, 2006). Nonetheless, at wells that typically experience sharp drawdown and dewater with minimal purging, the alternatives are very limited.

Some entities employ a “no-purge” sampling technique at low-producing and other wells. (In this use of the term, “no-purge” samples are collected from water initially present within the well casing, rather than purging that water and collecting samples from the recharge (if any); this latter process is the traditional sampling method at Rocky Flats.) The reason for using the no-purge method is often related to a desire to reduce the costs of monitoring, including disposal of purge waters and the labor required to purge and sample a well. The no-purge method has been reported to be applicable to carefully selected fuel-hydrocarbon sites (Newell et al. 2000), although this study advocates the collection of sets of purge/no-purge samples for comparison before adopting the no-purge method. A study by the Western States Petroleum Association (WSPA) (1996) in California suggests such a method is appropriate for wells meeting six criteria, the first of which is that the well is “only impacted by gasoline hydrocarbons.” Both of the aforementioned reports are based on large data sets comprising hundreds of wells, although it

appears the wells produced adequate water and did not go dry (and therefore may not be directly comparable to wells in the Rocky Flats study). Conversely, Barcelona (1997) has a somewhat different view of no-purge sampling: “the ‘method’ is a fraud.” EPA (2002, p.44) describes the utility of well purging as follows:

“In most cases, the standing water in the well casing can be of a different chemical composition than that contained in the aquifer to be sampled. Solutes may be adsorbed or desorbed from the casing material, oxidation may occur, and biological activity is possible. Therefore, the stagnant water within the well must be purged so that water that is representative of the aquifer may enter the well.”

It is important to note, however, that many (e.g., Negrao and Kaminski 2007) have recognized that in some cases, the standing water in the casing—or some portion of it (i.e., that in the screened interval, where the top of the screen is submerged)—may be representative in some settings or may simply represent the best available sample water, given various imperfect alternatives. Because of the lack of strong consensus in the literature, a Site-specific evaluation of the method was appropriate.

Description of the Evaluation

When analytical data are used to make decisions related to compliance, a complete absence of sample data is preferable to the collection and use of nonrepresentative sample data. Therefore, an evaluation was begun to determine whether using the no-purge sampling method at Rocky Flats yields samples that are significantly different in contaminant concentrations from those collected following a well purge. If not, the method would be adopted for use for groundwater sampling at Rocky Flats.

Parallel sampling at the Site was attempted from late 2005 through the end of 2007. The wells where this was conducted were located across the COU, and were selected because they often fail to recover during sampling. (The following point needs to be stressed. This entire evaluation is focused solely on low-producing wells that often go dry during the purge. It is not known whether findings from this evaluation would be applicable to more productive wells; additional data would be needed to determine broader applicability.) The intent at each selected well was to collect a sample using the no-purge method (the “no-purge sample”), then purge (and typically dewater) the well and collect a second sample (the “purge sample”). In most cases, the analytical suite was limited to VOCs; however, nitrate, total U, and/or metals were included at some locations. (Samples for the first two suites are collected without filtering, while the last two samples are field-filtered using a 0.45-micron [μm] in-line filter.)

Many of the wells selected for this study did not provide adequate water to meet the study objectives. In some cases they were dry and provided no samples; in other cases, they provided the no-purge sample but not the purge sample. Further complication resulted from the need to return to some wells at a later date to collect the purge samples, because recharge was so slow. The resulting temporal gap between samples ranged from several hours to over 6 weeks. Such a long period between samples clearly raises the question of whether both such samples can be considered to represent the same groundwater, and whether the latter sample could accurately be described as a purge sample as opposed to simply another no-purge sample. Finally, even when both samples were successfully completed, if analytical results from both methods were reported as nondetects, the associated data were of no benefit to this evaluation. In the end, the total

number of complete sample sets (i.e., one no-purge sample and one purge sample from the same well, representing the same sampling event, for the full scheduled analyte suite) that were successfully collected was 29.

Analytical results of these samples were assembled. Only paired samples were included in the assessment; if a well did not produce both the no-purge and purge samples for a given sampling event, analytical data for the event were eliminated from this evaluation. Furthermore, if those two samples were separated by more than 2 days, they were removed from the evaluation. This was because most of the comparisons were based on VOC samples. In several cases, both a “real” and a “field duplicate” sample were collected from a well for either the no-purge or purge sample. In these cases, both were used and compared with the sample collected using the other method.

Data gathered during this evaluation were first examined; results for analytes that were not detected in either sample were removed from the data set. The final data set was then assessed statistically using both the ANOVA and Mann-Whitney methods. A modified interwell comparison was made, in which no-purge data were assigned upgradient and purge downgradient positions. Finally, a qualitative, visual comparison of the data was performed.

Results and Discussion

Table 3-94 summarizes the numbers of sample sets attempted and successfully collected for this evaluation. As noted in the table, seven sample sets were not successfully collected due to dry conditions, and temporal separation (i.e., too much time between no-purge and purge samples) affected two sample sets.

Both the ANOVA and Mann-Whitney statistical methods found the data set to be too small to support an effective statistical analysis. This is not surprising, given that most locations evaluated for this study successfully produced only one set of samples (Table 3-94). Given the time and labor requirements and difficulties associated with sample collection related to water availability, it would be overly costly to continue to collect and analyze purge and no-purge sample sets from low-producing Rocky Flats wells until they are sufficient in number to support a robust statistical evaluation of the two sampling methods, yielding results with a high degree of confidence. Even so, the data that have been collected are useful for a qualitative comparison of the methods, and combined with published studies can serve as an indication of whether the no-purge method might be appropriate for use at Rocky Flats.

Two types of displays of the data were prepared to allow a visual comparison of the methods. One is a tabulation of the analytical data, allowing simple observation of the numerical differences in the results generated by the two sampling methods. The second employs graphical comparisons of these data.

Table 3-94. Tally of No-Purge/Purge Sample Sets Collected from 2005-2007

Well	VOCs		Uranium		Nitrate		Metals		SVOCs		Total Attempted	Total Collected
	Attempted	Collected	Attempted	Collected	Attempted	Collected	Attempted	Collected	Attempted	Collected		
00797	1	1	1	1							1	1
04091	1	1									1	1
10594	2	2	2	2	2	2					2	2
10992	2	2									2	2
11092	1	0									1	0*
15699	1	1									1	1
21505	1	1									1	1
4087	3	1	3	1	3	1					3	1*
4787	1	0									1	0*
4887	1	0									1	0*
70099			1	1	1	1					1	1
73005	3	3	3	2			3	2			3	2**
73205	1	0					1	0			1	0*
80205	1	1	1	1			1	1	1	1	1	1
88104	1	1	1	1							1	1
90299	3	1									3	1*
90399	5	5									5	5
90402	1	1									1	1
91305	1	1	1	1	1	1					1	1
95099	1	1									1	1
95199	1	1									1	1
95299	3	0									3	0*
99305	1	1	1	1	1	1					1	1
99405	1	1	1	1	1	1					1	1
B206989	3	2	3	2	3	2					3	2**
P210089	1	1	1	1	1	1					1	1
Total	41	29	19	15	13	10	5	3	1	1	42	29

Notes: Attempted = number of sampling events in which a pair of samples (no-purge and purge) was attempted to be collected. Collected = number of sampling events in which a pair of samples (no-purge and purge) was successfully collected. * = Dry conditions/insufficient water prevented collection of all sample sets attempted. ** = Temporal separation between the no-purge and purge samples caused removal of the associated data from the data set.

Table 3-95 provides a summary table of VOC data from this study, and Table 3-96 summarizes data for inorganic constituents. (Inorganics include metals and nitrate. U is grouped with metals.) Results are presented if (after the data management steps described above) more than two high-confidence data points (i.e., not U-, J-, or B-qualified) are represented in the full data set, and the constituent is listed in the table of RFLMA action levels (DOE 2007d). This was done to reduce the table to a manageable size, and also because the resulting table tends to summarize the more commonly detected (and therefore more important, on a Site-wide basis) constituents. Refer to Appendix B.7 for the full set of no-purge and purge data.

Table 3-95. Summary of Analytical Results (µg/L) for No-Purge and Purge Samples: VOCs

Location	Sample Date	1,1-DCE		Carbon Tetrachloride		Chloroform		cis-1,2-DCE		PCE		TCE	
		NP	P	NP	P	NP	P	NP	P	NP	P	NP	P
00797	12/12, 14/05											0.58 (J)	0.2 (U)
04091	11/8/07			0.19 (U)	0.21 (J)								
10594	12/12, 14/05											0.51 (J)	0.2 (U)
15699	11/6/07	14	32					400	370	5.7	130	130	480
21505	5/24/06	1.5	0.6 (J)			0.66 (J)	0.29 (J)	3.2	1.5	4.6	1.3	25	8.9
88104	10/22, 23/07									0.2 (U)	0.22 (J)	0.16 (U)	0.24 (J)
90299	4/18/07			0.48 (J)	0.19 (U)	1.6	0.53 (J)					0.93 (J)	0.32 (J)
90399*	12/12, 13/05	1.3	1.3	250 (D)	310 (D)	29 (D)	37	3.8	3.3	8.6	9.2	280 (D)	320 (D)
		1.2		250 (D)		28 (D)		3.6		8.8		280 (D)	
90399	6/13/06	1	1.2	210	240	39	43	3.8	4.4	8.2	9.1	350	380
90399	11/1, 2/06	0.34 (J)	0.76 (J)	120	140	28	29	2.4	2.5	3.5	3.9	170	180
90399	4/18/07	0.71 (J)	0.74 (J)	150	150	27	28	2.4	2.5	4.7	4.7	210	210
90399	11/6/07	0.87 (J)	1.3	140	200	34	40	3.7	4.2	4.4	5.1	300	370
90402	6/12/06	0.27 (J)	0.24 (J)	10	10	2.7	2.7	0.24 (J)	0.16 (J)	9.7	11	17	16
91305*	11/5/07							6.3	7.6				
									7.5				
95099	11/8/07			0.19 (J)	0.19 (U)								
95199	11/13/07	0.21 (J)	0.57 (J)			0.16 (U)	0.18 (J)	1.1	2.2	0.38 (J)	2.1	16	58
99305	11/1/07	0.14 (U)	0.29 (J)					6.9	10	1.8	4.2	27	75
99405*	11/5/07					0.18 (J)	0.16 (U)	1.1	1.4	0.47 (J)	0.83 (J)	69	120
							0.17 (J)		1.6		0.79 (J)		91
RFLMA Surface-Water Standard		7		5		3.4		70		5		5	

Notes: NP refers to no-purge samples, P refers to the purge samples. Results are not included if both were nondetects. **BOLD** results exceed the corresponding RFLMA action level (DOE 2007d). Qualifiers: J = estimated; U = analyte not detected at indicated detection limit; D = analysis run at a dilution. Analytes were omitted if they were represented by two or fewer sets of high-confidence detected results (i.e., not U-, J-, or B-qualified), or if they are not listed on RFLMA Attachment 2, Table 1 (DOE 2007d). *The second set of data represents a field duplicate sample.

Table 3-96. Summary of Analytical Results (µg/L except as noted) for No-Purge and Purge Samples: Inorganics

Location	Sample Date	Nitrate+ Nitrite as N (mg/L)		Boron		Uranium	
		NP	P	NP	P	NP	P
00797	12/12, 14/05					26	25
10594	12/12, 14/05	0.07	0.04 (B)			91	95
10594	11/1/07	0.2	0.14			110	130
4087	4/16/07	0.47	0.36			28	30
70099	10/30/07	0.095	0.52			260	280
73005	4/30/07			32	32	17 (B)	19 (B)
73005	10/15/07			32	34	25 (B)	25 (B)
80205	10/17, 18/07			71	69	69	94
88104	10/22, 23/07					51	47
91305*	11/5/07	0.074	0.25			48	54
			0.26				53
99305	11/1/07	0.019 (U)	0.34			63	61
99405*	11/5/07	3.9	4.2			440	400
			4.1				400
B206989	10/10/06	36	35			110	120
B206989	10/16/07	27	28			89	93
P210089	10/30/07	140	140			16	18
RFLMA Surface-Water Standard		10 or 100		750		120 (Threshold)	

Notes: NP refers to no-purge samples, P refers to the purge samples. Results are not included if both were nondetects.

BOLD results exceed the corresponding RFLMA action level or U threshold (DOE 2007d). (No Boundary wells were appropriate for this evaluation, so the 16 µg/L total U threshold applying to them is not listed as the U threshold.)

Qualifiers: U = analyte not detected at indicated detection limit; B = detected concentration was less than the required detection limit but above the instrument detection limit. Analytes were omitted if they were represented by two or fewer sets of high-confidence detected results (i.e., not U-, J-, or B-qualified), or if they are not listed on RFLMA Attachment 2, Table 1 (DOE 2007d). *The second set of data represents a field duplicate sample.

Several significant differences are immediately obvious on these tables. For example, Table 3-95 shows PCE and TCE results in the sample set from well 15699 differ markedly between the purge and no-purge methods, with the no-purge sample result for PCE reported at 5.7 µg/L while that for the purge sample is reported at 130 µg/L. For TCE, these results are reported as 130 µg/L and 480 µg/L, respectively. There are also instances in which the no-purge sample is reported to contain higher concentrations of a constituent (such as cis-1,2-DCE in the same sample from well 15699, with a no-purge result of 400 µg/L, and a purge result of 370 µg/L). However, where differences exist between the results, in most cases the purge sample is reported at a higher concentration than the no-purge sample. For inorganic constituents (Table 3-96), the results are more mixed.

Graphs of the data were also prepared that plot purge versus no-purge results. Each point on the graph has the coordinates x = no-purge result and y = purge result for a specific well/constituent/sample date combination. For clarity, details of the various constituents and well numbers are omitted. (Refer to Appendix B.7 for the full data set.)

Two graphs incorporate the methods employed when evaluating Rocky Flats groundwater data that are qualified either by the laboratory or through the data validation process as nondetects: these results were replaced with a value of 0.001. To provide a comparison with a convention

that is widely used when evaluating analytical data including nondetects, two other graphs were prepared in which the nondetects were replaced by a value equal to one-half the reported detection limit.

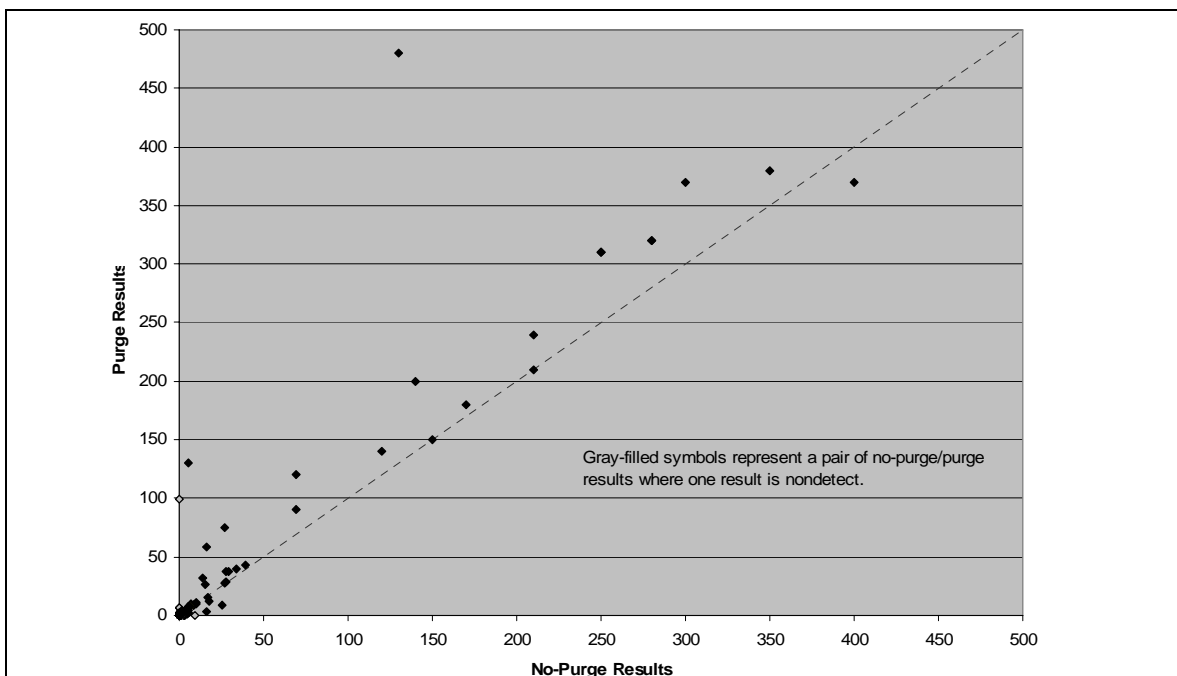
Only data with relatively lower concentrations, in the 0–500 µg/L (or mg/L, in the case of nitrate) range, were included for this report. This is for two reasons. First, the Rocky Flats groundwater monitoring program is focused on detection and compliance monitoring, and most of the applicable action levels are in this range (DOE 2007d). That is, groundwater is monitored to detect the presence of contamination, particularly as the groundwater nears surface water, and to determine whether the groundwater may pose a threat to surface-water quality. Groundwater data are compared against surface-water action levels, and decision rules are largely based on these compliance standards. Therefore, it is appropriate to focus more closely on the concentration range represented by these standards. Second, most of the results in the data set compiled for this evaluation fall in this range; those that do not (which exclusively represent calcium, magnesium, potassium, silica, sodium, and strontium) are of less (or no) importance to the monitoring program.

A 1:1 line was added to the plots. If both sampling methods yield samples that are equivalent, and the usual laboratory and field uncertainties are nonexistent, all points will plot on this line regardless of sampling method. However, these uncertainties do exist, so if both methods result in equivalent samples the points should plot along the 1:1 line, with points equally distributed on both sides of and preferably fairly close to the line.

Results of this graphical approach are provided on the following figures. Figure 3-233 and Figure 3-234 illustrate this comparison for VOCs when nondetects are replaced with 0.001 and with one-half the detection limit, respectively, Figure 3-235 and Figure 3-236 represent inorganics, using the same nondetect replacements, respectively.

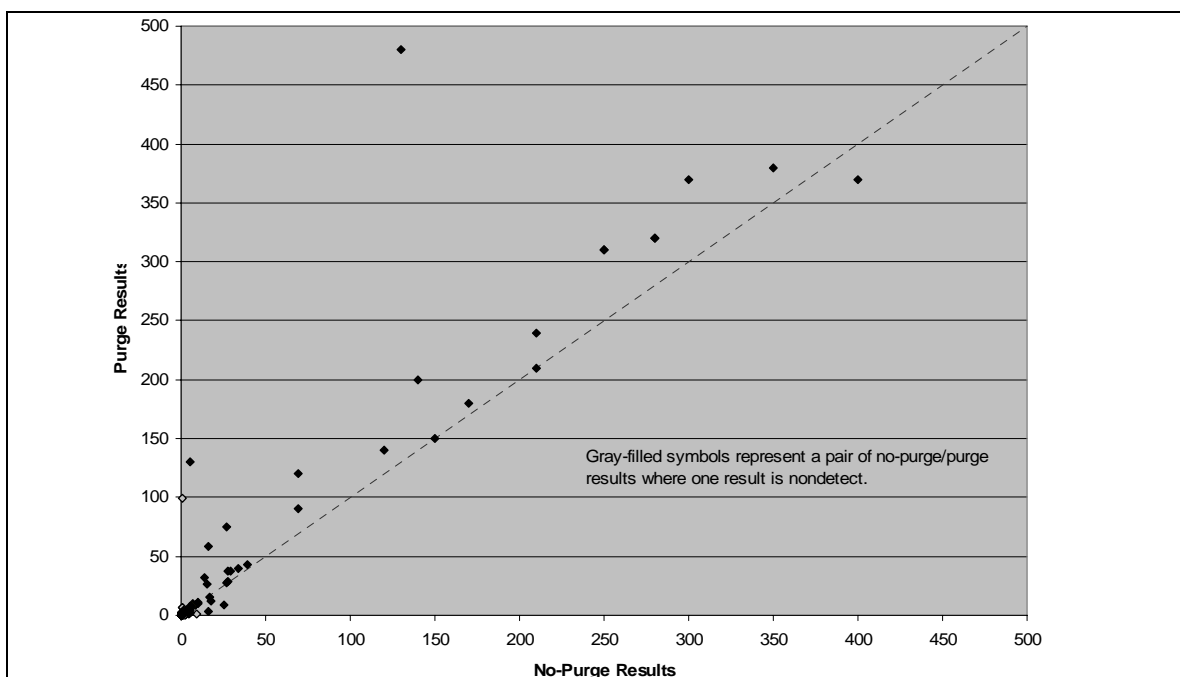
From these figures, it is fairly obvious that there is a difference in results generated by the two sampling methods with respect to organic constituents (Figure 3-233 and Figure 3-234). Regardless of whether nondetects are replaced with one-half the reported detection limit or 0.001, reported VOC concentrations are frequently higher when the purge method is used to collect samples; more points on these figures plot above the 1:1 line than below the line. This indicates that these differences cannot be attributed solely to analytical or field uncertainties, because if that was true there would be an even distribution of points on both sides of the line. Therefore, samples collected using the no-purge method are biased toward lower VOC concentrations, even in comparison to the data from many samples collected from recharge after the well dewatered.

The differences are not as clear when samples are analyzed for inorganics, as shown on Figure 3-235 and Figure 3-236. Additional no-purge and purge sets of data for inorganic constituents would need to be collected to support a conclusion of whether any bias is present.



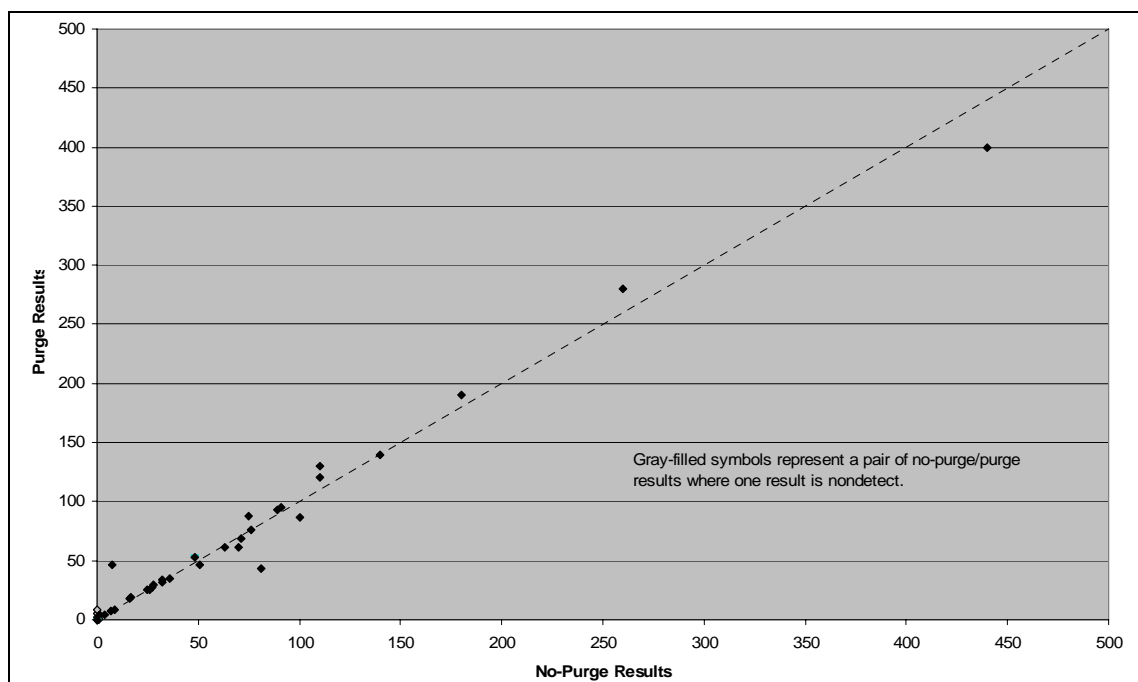
Notes: Diagonal line represents 1:1 (points plotting on this line were reported at the same concentration, irrespective of sampling method). See Appendix B.7 for the full data set.

Figure 3-233. Plot of No-Purge vs. Purge Results for VOCs: Nondetects Replaced with 0.001



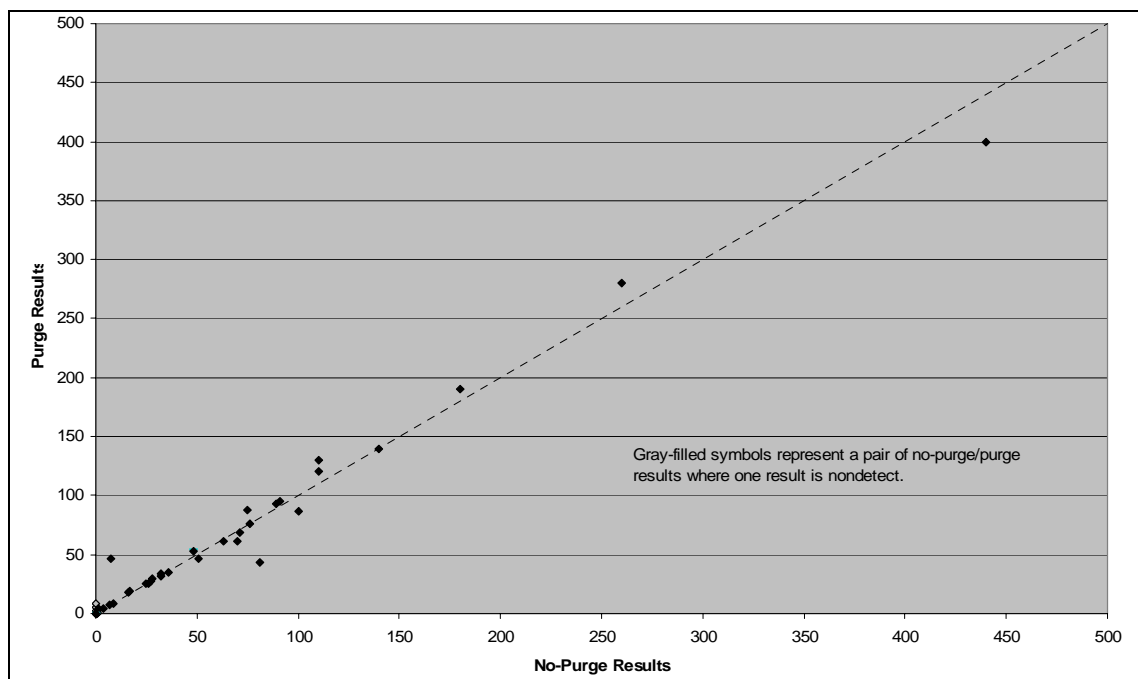
Notes: Diagonal line represents 1:1 (points plotting on this line were reported at the same concentration, irrespective of sampling method). See Appendix B.7 for the full data set.

Figure 3-234. Plot of No-Purge vs. Purge Results for VOCs: Nondetects Replaced with One-Half the Reported Detection Limit



Notes: Diagonal line represents 1:1 (points plotting on this line were reported at the same concentration, irrespective of sampling method). See Appendix B.7 for the full data set.

Figure 3-235. Plot of No-Purge vs. Purge Results for Inorganics: Nondetects Replaced with 0.001



Notes: Diagonal line represents 1:1 (points plotting on this line were reported at the same concentration, irrespective of sampling method). See Appendix B.7 for the full data set.

Figure 3-236. Plot of No-Purge vs. Purge Results for Inorganics: Nondetects Replaced with One-Half the Reported Detection Limit

To a degree, the finding that purge samples contain higher concentrations of VOCs is intuitively reasonable. Because these constituents readily volatilize (hence the term “volatile organic compounds”), they would be expected to be present at lower concentrations in stagnant water within the well casing than they would be in formation water. Even with the effects of aeration as the dewatered wells recharged with water that cascaded through the filter pack and screen, purge samples are generally higher in VOCs than are no-purge samples. Conversely, metals do not volatilize as readily. However, this is not to say that inorganics in fresh formation water will be identical to those in stagnant water within the well casing, either in terms of concentration or speciation. Metals can sorb to sediments at the bottom of the well or in the filter pack, or to the well casing itself, and can precipitate, all of which would effectively reduce metals concentrations. The opposite can also occur: sorbed, mineralized, or corroding metals can be liberated into stagnating water if geochemical conditions are right (Puls and Barcelona 1996; Boylan 2004; Vandenberg and Varljen 2000). (It should also be noted that some VOCs can sorb to sediments, suggesting the possibility that purged samples could be higher in VOC concentrations simply because more particulates were included in the samples of agitated water collected following the purge than in samples of less-turbid water in the no-purge samples. No attempt was made to review turbidity data to determine whether this might be a significant factor.)

Nitrate concentrations may be reduced via bacteria within the well or filter pack. With respect to speciation, if it is important to determine nitrite concentrations (for example), fresh formation water would need to be collected and analyzed because any nitrite present in the water would typically react quickly with atmospheric oxygen within the well casing to become nitrate. Other redox-sensitive constituents can also undergo chemical changes, potentially resulting in poor decisions if based on data from samples of stagnant water (for example, with respect to concentrations of Cr-III vs. Cr-VI; Hg-0 versus Hg-II versus methylmercury, CH₃Hg; various lead species; and so on).

As wells at Rocky Flats (and most other locations) are purged the conductivity, or specific conductance, of the purge water initially varies, and finally stabilizes. This parameter is a measure of the electrical conductivity of the water, and is a useful reflection of major-ion chemistry (most commonly represented by such species as sodium, calcium, potassium, iron, magnesium, chloride, sulfate, nitrate, and phosphate). By varying as the well is purged, the conductivity is indicative of varying concentrations of the ionic components in the water. Conductivity is affected by water temperature, which also varies as the well is purged until reaching a stable level. The gradual stabilization of these parameters as a well is purged is an indication that the stagnant water in the casing is not completely representative of formation water at that location.

Barcelona et al. (1994) report on a study focusing on variations in field parameters and VOC concentrations as wells were purged. They found dissolved oxygen (DO) content and conductivity stabilization to be most indicative of an adequate purge, and report the corresponding purge volume to be consistently less than one-half of a bore volume (where the bore volume is equivalent to the volume of water contained in the sand pack, screen, and well casing). More recently, Vandenberg and Varljen (2000) report on a study in which field parameters, again including DO and conductivity, were monitored and samples collected for analysis of major ions, VOCs, and metals as wells were purged. The results indicated each of

these varied as the purge proceeded, stabilizing after one-half to two casing volumes (not bore volumes) were purged.

The data reported by Newell et al. (2000), in a paper advocating wider use of no-purge methods, also indicate a small amount of bias in the data. Plots of benzene concentrations from six individual studies of no-purge versus purge sampling are presented, and include calculated regression lines. The slopes of the regression lines for four of the six individual studies are weighted toward the purge data, indicating purge samples were slightly higher in benzene concentration than no-purge samples. The regression line calculated for the data compiled from all six studies is also biased in this direction, although more slightly. Note that these lines do not differ greatly from a slope of 1, with the individual study data sets represented by regression lines that range in slope from 0.92 to 1.03 (where a slope less than 1 indicates the purge samples are higher in concentration than no-purge samples). The correlation coefficient, r^2 , for these studies ranges from 0.68 to 0.87; the numbers of sample sets range from 29 to 480, with a total for all six studies of 736.

Newell et al. (2000, p.8) also caution that “underestimation of VOC concentrations is most likely to occur: i) in relatively low-permeability formations (with slow seepage velocities and long in-well residence time); and ii) at lower VOC concentrations.” They recommend (p.9) a comparison of data representing purge versus no-purge samples “to evaluate potential for bias toward lower concentrations in the No-Purge samples.”

Conclusions and Recommendations

It should be reiterated that when the analytical results are used to evaluate compliance with water-quality standards, a complete lack of analytical data is strongly preferred over the acquisition and use of biased data—even if this means that efforts required to collect a sample cause the well to dewater and not produce any data at all.

This evaluation showed that samples collected using the no-purge method are not consistently equivalent to those collected using the purge method. Historically, low-producing wells at Rocky Flats were sampled using the purge method, and decisions were based on data reported from the associated samples. Therefore, if the no-purge method does not produce samples that are equivalent to purge samples, the associated data should not be pooled with and considered equivalent to these historic data.

If detailed results with minimal chance of bias are required—for example, when the data support decisions related to compliance—the no-purge sampling method does not appear to be appropriate for groundwater sampling at Rocky Flats. This is especially evident for VOCs, and sufficient doubt is present in the literature to suggest this applies also to inorganic constituents. Even if the higher VOC concentrations in purge samples are a result of increased turbidity—a possibility that was not confirmed as part of this study, and which would require specialized analyses to confirm VOCs are truly sorbed to the particulates and would not be present in such high concentrations without the presence of these solids—the purge sample at least provides a conservative indication of concentrations. To support a detection monitoring program that incorporates many wells screening relatively low-permeability deposits, as is the case at Rocky Flats, the well should be purged before samples are collected. However, for the collection of field screening-level information intended to determine the presence of contaminants at relatively higher concentrations, the no-purge method would appear to be appropriate.

A fundamental question remaining to be answered is, what sampling method at low-yield wells is both efficient and produces groundwater samples that are truly most representative of formation water? This evaluation did not attempt to resolve that question, and as indicated this subject is actively being studied. It is likely that “the best” and “most representative” sampling method at low-yield wells would not be defined by a universally applied set of specific criteria (e.g., casing volumes purged), but rather a well-specific determination based on water availability, well design, hydrogeology, and analytical suite. Other possible method candidates include “passive” sampling (as described by Negrao and Kaminski [2007]) and the use of passive samplers (such as passive diffusion bags or grab samplers [Kaminski 2006]).

Based on results from this evaluation and the supporting literature reviews, low-yield wells at Rocky Flats will be purged before samples are collected. Low-flow methods will be used as practicable, the intent being to minimize disturbance of the water column and collect low-turbidity samples. The no-purge sampling method will not be used.

High-Resolution Analysis of Water Samples for U Isotope Characterization

Samples were collected from six established groundwater and surface-water monitoring locations for characterization of their U content using the TIMS high-resolution analytical method. Results obtained through these analyses may be used to determine the isotopic distribution of U—its isotopic signature—and whether the water reflects any anthropogenic (manmade) U, and if so, how much. This information will be useful in discussions with the WQCC regarding the U standard in place at the Site (see Section 2.3), and two of the locations were recommended for this evaluation in the CERCLA 5-year review (Section 2.2).

Five of the locations that were selected for this sampling were previously characterized for their U signature on at least one occasion. However, all previous data were from the pre-closure era. Therefore, at those locations the general objective was to see whether post-closure results varied significantly (in a qualitative sense) from pre-closure results.

One location had not been previously characterized for its U content. Downgradient OLF RCRA well 80205 was recommended for this analysis in the 2006 Annual Report (DOE 2007e), as discussed in Section 3.1.2.9.

Samples were shipped to LANL for analysis. LANL is the same laboratory that performed similar analyses for numerous monitoring locations prior to closure, using both the TIMS analytical method and the HR ICP/MS method. The associated results have been published in various reports, including individual Annual RFCA Groundwater Monitoring Reports (e.g., RMRS 2000; SSOC 2001, 2002; K-H 2004b), the report on U in various media at Rocky Flats (K-H 2004e), and the summary report by Janecky (2006) that tabulates all such data collected from 1998 through 2005.

Table 3-97 summarizes the 2007 sampling effort and associated results. See Figure 3-202 for a map of sampling locations, and refer to Appendix E for the complete analytical report.

Table 3-97. High-Resolution U Isotopic Characterization in 2007

Location	Area	Date	Objective	Total U result, µg/L	% Natural
80205	OLF	9/7/07	Initial characterization	79.2	100.0
10594	Pond A-1	9/11/07	Follow-up	103	96.8
99405	B991	9/12/07	Follow-up	439	99.9
SPP DG	SPPTS	9/12/07	Follow-up	62.0	42.9
GS03*	Walnut/Indiana	7/9/07	Follow-up	3.71	76.9
GS10	South Walnut Creek	7/23/07	Follow-up	10.1	70.5

Notes: * = Due to a typographical error in the third quarter CY 2007 report (DOE 2008a), data from this location were misattributed to GS13. Walnut/Indiana = Walnut Creek/Indiana Street intersection. Locations listing the objective as "Follow-up" have been characterized by LANL for U isotope signature in the past.

Because groundwater samples from well 80205 had not been characterized for U isotopic signature before, no comparison with previous results at this location is possible. However, all other locations listed in Table 3-97 have been so characterized before. In all but one case, results from 2007 are consistent with those reported previously. At the SPP DG, however, some change was suggested. Only one previous TIMS or HR ICP/MS result is available for this location. As noted in the analytical report for the samples collected in 2007 (Appendix E), this location was previously characterized using a sample collected on June 18, 2002. That sample provided a result of 67.2 percent natural U, whereas the sample collected in 2007 reported 42.9 percent natural U.

Reasons for this variation are not known, but can be hypothesized. By far the most likely cause relates to the many significant changes to physical systems (including hydrology) in this area that occurred between June 2002 and September 2007. During that time, the SEPs (the source area for the nitrate and U treated by the SPPTS) were closed; numerous culverts that had controlled surface water in the North Walnut Creek drainage west of the SPP DG were removed and FC-3 was constructed; the impermeable surface that was the North Perimeter Road (generally overlaying the SPPTS groundwater intercept trench) was removed; much of the area between the SPP DG and the SEPs was regraded; the ITS was disrupted; and other physical attributes were changed.

Any one or several of these mechanisms, and/or others not mentioned, could have contributed to the differences in U signature reported. Perhaps more importantly, the difference may relate to sampling and analytical uncertainties. First, pre-closure conditions are represented by only a single sample, as are post-closure conditions. Those conditions may vary significantly over short time periods. This has been reported over the years at other Rocky Flats locations (Janecky 2006, also reported in the respective Annual Reports). For example, pre-closure LANL data for natural U content in samples from well 07391 (the Ryan's Pit source-area well) have shown variations of more than 20 percent over a period of approximately 6 months. (A sample collected in January 2000 reported no natural U, a sample collected in June 2000 reported 21.1 percent natural U, and a sample collected in March 2001 reported 7.6 percent natural U.) Therefore, the variation reported at SPP DG between two samples collected from 2002 to 2007 may be another example of this.

Sampling and analytical uncertainty may also be significant factors. Prior to closure, samples provided to LANL were typically 500 mL or 1 L in volume. Since that time, however, the laboratory requirements have changed; now, a sample is limited to the volume represented by

2 µg of total U. A sample from the SPP DG, therefore, is now represented by a volume that is much smaller (and therefore, potentially less representative) than was the case before closure. For example, the sample supplied to LANL for the 2007 analysis was reported to contain a total U concentration of 62 µg/L, meaning only approximately 32 mL of sample could be shipped for this location. (For well 99405, with a reported total U concentration of 439 µg/L, the sample volume would need to be even smaller, not quite 5 mL.) Clearly, in an area known to contain anthropogenic U, the effects of a small quantity of this anthropogenic U—potentially in the form of a solid particle, as the sample of water from the SPP DG that was provided to LANL was not field-filtered—could cause a shift in the isotopic signature from predominantly natural to anthropogenic.

Additional data will be collected from the SPP DG to further explore isotopic U variability at this location. Assuming weather conditions permit, in 2008 samples will be collected to represent both lower-flow and higher-flow conditions at several locations, including the SPP DG. Although the mechanism(s) responsible for the variations noted above may not be identified, the resulting data will help to refine the U signature at this location.

Regrading at the VC Plume Source Area

Following significant snowmelt and precipitation events, several large puddles were typically present in the area of the IHSSs thought to be the source of the VC Plume. As noted above and discussed in K-H (2004a), of all Rocky Flats this area represents that most conducive to natural biodegradation of VOCs. This is due to the reducing conditions of groundwater here, presumably a result of the decaying vegetation in this buried valley.

The presence of lingering puddles in this area caused a concern that relatively oxygen-rich surface water would infiltrate the ground and hamper continuing anaerobic biodegradation of residual parent VOCs, which might result in expansion of this plume and a change to a more parent compound-rich contaminant characteristic. Therefore, in 2007 the area was regraded, with soil excavated from nearby FC-1 (thereby simultaneously improving the gradient there) and spread on the surface generally around wells 33502, 33604, and 33703. The intent of this regrading effort was to force rain and snowmelt to drain off the area into FC-1 and FC-2, rather than collect in puddles over an area of residual subsurface VOC contamination. See Section 2.7.3 for additional information on the regrading work.

3.2 Air Monitoring

3.2.1 Introduction

Air monitoring and emissions assessments have been performed at the Site since the Site began operations in the early 1950s. The Site has historically been subject to 40 CFR 61, Subpart H which specifies radionuclide air emissions limitations and monitoring requirements for DOE facilities. However, following decommissioning and environmental restoration activities pursuant to RFCA (CDPHE et al 1996), completed in fall 2005, the remaining DOE-retained lands are no longer a “facility” as defined in 40 CFR 61.91(b). Consequently, 40 CFR 61, Subpart H, no longer applies.